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UNDESCRIBED PLANTS FROM GUATEMALA AND OTHER CENTRAL AMERICAN REPUBLICS. XXI.[1]

JOHN DONNELL SMITH.

HAMPEA INTEGERRIMA Schlect., var. **appendiculata** Donn. Sm.—Folia ovato-lanceolata sursum sensim acuteque angustata juxta petiolum appendicibus duabus semiorbicularibus supra instructa.

Arbor 10^{m} alta, trunco diam. 3-decimetrali, coma globosa, floribus suaveolentibus.

In pascuis prope La Palma, Costarica, alt. 1550^{m}, Aug. 1898, *Tonduz*, n. 7379 Pl. Guat. etc., qu. ed. Donn. Sm. (n. 12462 herb. nat. Cost.).

Polyaster paucijugus Donn. Sm.—Folia magna quadrijuga, rachide nudo, foliolis petiolulatis discoloribus oblongo-lanceolatis acuminatis, lateralibus basi inaequali obtusis, terminali utrinque acuto. Panicula terminalis obpyramidata. Petala lineolata. Filamenta glabra.

Ramuli cum paniculis flavo-velutini. Folia petiolo 8^{cm} longo adjecto 3.5^{dm} longa raro trijuga, foliolis 8–10^{cm} longis 3–3.5^{cm} latis epunctatis supra glabrescentibus subtus infra lanam flavam insigniter reticulatis, petiolis lateralibus 2–3^{mm} longis, terminali 1.6^{cm} longo. Panicula efoliata folia superiora aequans repetitus dichotoma, pedicellis quam flores brevioribus. Calycis patuli 2.5^{mm} lati dentes triangulares glabri. Petala 6^{mm} longa 2^{mm} lata, margine involuto, apice acuto inflexo. Torus obpyramidatus 1^{mm} altus glaber

[1] Continued from BOT. GAZ. **25**:157. 1898.

10-sulcatus. Stamina majora petala paene aequantia, cetera dimidio breviora, antheris orbicularibus. Ovarium subapocarpum, carpellis torum paulo superantibus totis cano-pilosissimis ima basi tantum coalitis ope stylorum sublateralium cohaerentibus collateraliter biovulatis. Fructus ignotus.— Haec species a typo generis (*P. bromioide* Benth. et Hook., ad n. 874 Coulter!) cum in diagnosi tum foliis paniculisque decies majoribus distinctissima est.

Maxac, Depart. Huehuetenango, Guat., Jul. 1896, *Seler*, n. 3090.

BURSERA BIPINNATA Engl., var. **ovatifolia** Donn. Sm.— Rami novelli et floriferi cinereo-pilosi. Foliola supra pubescentia subtus tomentulosa ovata aut late ovalia, margine revoluto. Pedicelli fructiferi 4 mm longi. Drupae oblongo-ellipticae 8 mm longae stylo persistente apiculatae. An sit species nova?

Depart. Huehuetenango, Guat., alt. 1400 m, Jul. 1896, *Seler*, n. 3108.

Copaifera hemitomophylla Donn. Sm.— Foliola unijuga ad apicem petioli brevissimi sessilia dimidiata maxima lanceolato-oblonga acuminata basi exterius acutiuscula interius acute truncata glabra impunctata crebre nervia reticulato-venosa. Legumen magnum valde obliquum orbiculare turgidum, semine exarillato.

Arbor excelsa, coma globosa (Tonduz in schedulis), ramulis subflexuosis lenticellis punctatis. Petioli crassi corrugati 6–8 mm longi, foliolis suberectis 11–15 cm longis 4–4.5 cm latis basi ad articulationem incrassatis. Pedunculus axillaris vix ullus aut usque ad 1 cm longus, pedicellis pauciaggregatis (in speciminibus suppetentibus 1–3-nis), 8–12 mm longis, leguminibus breviter stipitatis 4–4.5 cm longis 3.5–4 cm latis 1.8–2.2 cm crassis vix apiculatis fusco-furfuraceis. Flores deficiunt.— Haec a ceteris speciebus bifoliolatis Americanis, nempe *C. hymenaeifolia* Moric. et *C. confertiflora* Benth., foliolis magnis et oblongatis discrepat.

Santo Domingo de Golfo Dulce ad litora maritima, Cost., Mart. 1896, *Tonduz*, n. 7012 Pl. Guat., etc., qu. ed. Donn. Sm. (n. 9972 herb. nat. Cost.).

Myrcia Seleriana Donn. Sm. (*Aulomyrcia*, § CYMOSAE Berg, in Linnaea **27**: 71.)—Glabra. Folia coriacea subevenia utrinque impellucido-punctata lanceolata, apice obtuse acuminato, basi cuneata. Pedunculi axillares et terminales solitarii filiformes cymoso-triflori, flore intermedio sessili, lateralibus breviter pedicellatis. Calycis limbus utrinque tuberculatus usque ad medium lobatus, lobis 4 semiorbicularibus quam quintus orbicularis dimidio minoribus. Ovarium biloculare. Bacca abortu monosperma.

Folia 4–5^{cm} longa 1.5–2^{cm} lata e medio utrinque angustata, costa subtus tantum manifesta, nervis venisque subimmersis, punctis atris, petiolis 5^{mm} longis. Pedunculi fructiferi 2.5–3.5^{cm} longi, pedicellis 5^{mm} longis bracteas persistentes lineares stipitatas aequantibus. Lobi calycini ciliati, minores 1^{mm} alti. Antherarum loculus alterus altius affixus. Ovarium 4-ovulatum. Bacca globoso-ovalis 4^{mm} longa bracteolis dimidio brevioribus calyculata. Petala in specimine suppetente deficiunt.—*Aulomyrciae subaveniae* Berg proxima, ut videtur.

Chaculá, Depart. Huehuetenango, Guat., alt. 1600^{m}, Jun. 1896, *Seler*, n. 3169.

Eugenia pachychlamys Donn. Sm. (§ GLOMERATAE Berg l. c. 183.)—Rufo-tomentosa. Folia primo utrinque tomentosa deinde praeter costam glabrescentia et supra lucida obovato-elliptica aut elliptica in acumen obtusum producta deorsum cuneata longiuscule petiolata. Flores axillares et subterminales subglomerati pauci majusculi petiolos aequantes, pedunculo pedicellisque vix ullis. Calyx crassus, segmentis utrinque tomentosis aequalibus.

Frutex 2–3^{m} altus (Heyde et Lux in schedulis). Folia disticha coriacea pellucido-punctata 7.5–9.5^{cm} longa 3.5–5^{cm} lata, petiolis 1.5^{cm} longis sicut ramuli tomentosis. Pedunculus solitarius 1–3^{mm} longus cum pedicellis 3–4^{mm} longis crassus et tomentosus, floribus 2–4 centripetim evolutis 4-meris diametro 2.5-centimetralibus, bracteolis crassis oblongis 5^{mm} longis, alabastris apertis obovatis 1^{cm} longis. Calycis supra ovarium haud producti tubus obpyramidatus 3^{mm} altus, segmenta ovata 6^{mm} longa. Petala praeter margines glabra oblongo-elliptica 1^{cm} longa genitalibus paulo longiora. Antherae ovales 1^{mm} longae glandula apiculatae prope basin affixae. Discus pilosellus 5^{mm} latus. Ovarii locula 2 multiovulata, stylo sparsim piloso. Baccae desunt.

Fraijanes, Depart. Amatitlan, Guat., alt. 1200^{m}, Apr. 1892, *Heyde et Lux*, n. 3961 Pl. Guat., etc., qu. ed. Donn. Sm.—Cerro Gordo, Depart. Santa Rosa, Guat., alt. 1100^{m}, Dec. 1892, *Heyde et Lux*, n. 4179 Pl. Guat., etc., qu. ed. Donn. Sm.

Eugenia Salamensis Donn. Sm. (§ CORYMBIFLORAE Berg l. c. 226.)—Exceptis foliis vetustioribus ferrugineo-velutina. Haec discoloria oblongo-aut obovato-elliptica apice obtusata aut brevissime obtuseque acuminata basi rotundata aut retusa. Corymbi axillares foliis dimidio breviores obpyramidati. Calyx usque ad discum partitus, segmentis utrinque velutinis oblongo-ovatis, alternis paulo majoribus acutioribusque.

Folia nascentia sicut ramuli petioli corymbi calyces ferrugineo-velutina, aetate provectiore supra nitentia subtus cinereo-pubescentia 11–12^{cm} longa 4–6^{cm} lata membranacea pellucido-punctata, petiolis 7–9^{mm} longis. Inflorescentia centripeta, corymbis ad axillas oppositas solitariis, axibus oppositis, pedicellis quam flores brevioribus bracteolas subulatas 5–7^{mm} longas subaequantibus. Calycis segmenta 5–6^{mm} longa. Petala extus pilosella obovata 7^{mm} longa genitalibus paulo breviora. Discus diam. 5-millemetralis praeter basin styli glaber. Ovarium parvum obpyramidatum biloculare, ovulis in utroque loculo circiter 12. Fructus ignotus.

Depart. Salamá, Guat., Dec. 1896, *Seler*, n. 2445.

Conostegia tenuifolia Donn. Sm.—Ramuli novelli cum petiolis et cyma stellato-puberuli. Folia glabra tenuiter membranacea majuscula disparia oblongo-obovata aut-elliptica in caudam tenuem acuminata basi acuta integra quintuplinervia. Cyma subcorymbiformis multiflora, alabastris ovoideis basi subtruncatis mucrunculo apiculatis. Petala 4–6 obdeltoidea valde inaequilatera emarginata. Stamina 16–22. Ovarium 10–12-loculare.

Folia pellucida in eodem jugo alterum 1.3–2^{dm} longum 5–7^{cm} latum, alterum magis obovatum 9–12^{cm} longum 3.5–5.5^{cm} latum, petiolis 0.5–3^{cm} longis. Cyma 4–6^{cm} alta, pedicellis 3–5^{mm} longis, alabastris pube stellata punctatis mucrunculo 1^{mm} longo adjecto 8–9^{mm} longis 4^{mm} crassis. Petala saepius 6 flava 8^{mm} longa atque lata. Antherae plerumque 20 oblongae 2^{mm} longae, filamentis 3^{mm} longis. Stylus crassiusculus 7^{mm} longus, stigmate capitato.—Juxta *C. puberulam* Cogn. et *C. Poeppigii* Cogn. locanda.

In sylvis prope Shirores, Talamanca, Cost., alt. 100^{m}, Febr. 1895, *Tonduz*, n. 9339 herb. nat. Cost.—Rio Pacuare, Llanuras de Santa Clara, Cost., alt. 150^{m}, Apr. 1896, *Donn. Sm.*, n. 6571 Pl. Guat. etc., qu. ed. Donn. Sm.—Rio Verde, Llanuras de Santa Clara, Cost., alt. 250^{m}, Maj. 1896, *Donn. Sm.*, n. 6574 Pl. Guat. etc., qu. ed. Donn. Sm.

Tococa parvifolia Donn. Sm. (§ ANAPHYSCA Benth. in Hook. Journ. Bot. **2**: 305).—Exceptis foliis glaberrima. Haec primo stellato-furfuracea denique praeter axillas subtus nervorum glabrescentia longiuscule petiolata e basi rotunda aut retusa lanceolata sensim acuteque angustata quintuplinervia supra medium mucro-serrulata. Cyma folia superans, ramis simplicibus trifloris, floribus 5–7-meris. Calycis limbus sinuato-lobatus dentibus filiformibus appendiculatus. Ovarium 3-loculare annulo crenato coronatum.

Suffrutex 1^{m} altus ramosus, ramis sicut cymarum axes purpureis nitentibus. Folia coriacea 5–8^{cm} longa 1.5–2.5^{cm} lata supra purpureo-maculata, basi conduplicata interdum supra biglandulari, nervis interioribus purpureis quam exteriores multo longioribus validioribusque, petiolis canaliculatis 1.5–2^{cm} longis. Cymae ramulos terminantes corymbiformes 6–9^{cm} altae ebracteolatae, pedicello intermedio vix ullo, lateralibus 1.5–2^{cm} longis, floribus saepius 5-meris 1.5–1.7^{cm} longis. Calycis tubus primo obconicus denique urceolatus 6–7^{mm} altus intus 10-costatus, dentes exteriores 4–5^{mm} longi. Petala oblongo-obovata 10–12^{mm} longa. Antherae 7–8^{mm} longae filamenta decurva aequantes valde incurvae, connectivo basi postice subbigibboso. Ovarium ovoideum 4^{mm} altum ultra medium liberum, sulcatum apice intrusum, stylo glabro 14^{mm} longo, stigmate punctiformi. Baccae non visae.

Santa Rosa, Depart. S. Rosa, Guat., alt. 600^{m}, Sept. 1893, *Heyde et Lux*, n. 6137 Pl. Guat. etc., qu. ed. Donn. Sm.

Henriettella tuberculosa Donn. Sm. (§ EUHENRIETTELLA Triana).— Folia scabrida supra tuberculata subtus foveolata ad nervos venasque strigosa in eodem jugo plus minus inaequimagna oblongo-obovata aut-elliptica longe acuteque cuspidato-acuminata in petiolum angustata integra 5-plinervia. Pedicelli brevissimi basi pluribracteosi, floribus 5-meris inter minimos. Calyx appresse paleaceo-strigosus. Petala obovata. Stylus elongatus.

Ramuli teretes scabridi, internodiis 1–1.5^{cm} longis. Folia subcoriacea 5–9^{cm} longa 2–3.3^{cm} lata, venis transversis rectis subtus tantum manifestis, petiolis 0.5–1^{cm} longis. Pedicelli 5–8-fasciculati 1^{mm} longi bracteas aequantes. Calyx 2^{mm} altus, limbo haud constricto vix dilatato minutissime denticulato, dentibus exterioribus acuminatis. Petala 2^{mm} longa obtusa. Filamenta incurva 2^{mm} longa, antheris 1^{mm} longis. Stylus 6^{mm} longus, stigmate capitellato.— *H. verrucosae* Triana proxima, ut videtur.

Talamanca, Cost., Apr. 1895, *Tonduz*, n. 7263 Pl. Guat. etc., qu. ed. Donn. Sm. (n.9906 herb. nat. Cost.)

Rondeletia Hondurensis Donn. Sm.— Stipulae e basi late ovata 1–3-setaceae. Folia subsessilia discoloria subtus niveo-arachnoidea oblongo-elliptica utrinque acuminata. Cyma terminalis subsessilis primo capitiformis denique confertim corymbiformis, bracteis stipuliformibus, floribus sessilibus maximis 5-meris canovillosis. Calycis segmenta linearia tubo longiora. Corollae tubus intus glaber, os haud constrictum nudum, lobi obovati inferne intus villosi.

Arbuscula, ramulis cymis floribus dense longeque villosis. Stipulae 1^{cm} longae basi 6^{mm} latae, setis 5^{mm} longis. Folia supra pubescentia utrinque ad nervos ferruginea $11–16^{cm}$ longa $3.5–5.5^{cm}$ lata, petiolis $2–4^{mm}$ longis. Cymae axes $4–10^{mm}$ longae, bracteae 1.5^{cm} longae, flores circiter 3–5-capitati. Calycis tubus obovatus $5–6^{mm}$ altus, lobi non satis aequales $10–14^{mm}$ longi acuti. Corollae tubus $2–2.5^{cm}$ longus, lobi 1^{cm} longi. Antherae 3^{mm} longae. Ovarium 2^{mm} altum, styli lobis exsertis ovatis 1.5^{mm} longis. Capsula ignota.— *R. dubiae* Hemsl. proxima.

Rio Chamelecon, Depart. Santa Bárbara, Honduras, alt. 300^{m}, Dec. 1888, *Thieme*, n. 5267 Pl. Guat. etc., qu. ed. Donn. Sm.

Gonzalea ovatifolia Donn. Sm.— Ramuli sicut spicae floresque appresse pilosi. Folia praeter nervos subtus pilosos glabra maxima ovata longe acuminata basi rotunda, petiolis brevissimis. Flores subspicati 4-meri bracteas aequantes. Calycis lobi inaequales. Corolla infundibuliformis ovario 3–4-plo longior ad $\frac{1}{3}$ longitudinis staminigera. Antherae sessiles basifixae. Bacca 4-pyrena, seminibus numerosissimis.

Frutex $3–4^{m}$ altus, ramulis ferrugineis. Stipulae e basi deltoidea $7–10^{mm}$ longae. Folia $1–1.5^{dm}$ longa $5.5–8.5^{cm}$ lata, basi nonnunquam inaequilatera et subacuta, petiolis $2–4^{mm}$ longis. Spicae $2–4.5^{dm}$ longae, bracteis sicut bracteolae dimidio breviores filiformibus, floribus pauciaggregatis. Calycis tubus 1.5^{mm} altus, lobi 3 ovati 1^{mm} longi quam quartus oblongus dimidio breviores. Corolla alba $5–6^{mm}$ longa ad duas partes superiores intus niveo-arachnoidea, lobis non satis aequalibus ovatis 1.5^{mm} fere longis obtusis prope basin intus pubescentibus. Antherae oblongae 1^{mm} longae. Ovarium 4-loculare. Bacca alba succosa globosa 4-sulcata pubescens diametro 5-millemetralis pyrenis osseis, seminibus pro pyrena circiter 35 atro-nitidis scrobiculatis.

Atirro, Prov. Cartago, Cost., alt. 600^{m}, Apr. 1896, *Donn. Sm.*, n. 6599 Pl. Guat. etc., qu. ed. Donn. Sm.— Rio Pacuare, Llanuras de Santa Clara, Cost., alt. 150^{m}, Apr. 1896, *Donn. Sm.*, n. 6600 Pl. Guat. etc., qu. ed. Donn. Sm.— Shirores, Talamanca, Cost., alt. 100^{m}, Febr. 1895, *Pittier et Tonduz*, n. 9171 herb. nat. Cost.— Eandem plantam legit *Hart* prope La Laguna de Chiriqui, Panamá, 1895, n. 113.

Hoffmannia tetrastigma Donn. Sm.— Ferruginea. Folia tenuiter membranacea supra tuberculato-asperula subtus praesertim ad nervos molliter pubescentia oblongo-elliptica acuminata in petiolum attenuata. Cymae fasciculatae pedunculatae petiolos superantes, floribus indefinitis. Calycis dentes triangulares.

Corollae lobi quam tubus dimidio fere breviores. Ovarium 4-loculare, stigmatibus 4 oblongis.

Stipulae triangulares. Folia integra petiolo 4-5^{cm} longo adjecto 28–35^{cm} longa 8.5–10^{cm} lata, costa subtus complanata 3^{mm} lata, nervis lateralibus utrinsecus 14–15 juxta marginem anastomosantibus. Cymae pubescentes 4–7-fasciculatae 6–9^{cm} longae, pedunculis 2–4^{cm} longis, bracteis ovatis 1^{cm} longis, floribus pubescentibus 4-meris numerosissimis. Calyx obovatus esulcatus 3^{mm} altus pedicellum subaequans. Corolla 11–14^{mm} longa, lobis oblongo-triangularibus 4–5^{mm} longis. Antherae obtusae 4^{mm} longae 1^{mm} latae. Ovarium vertice liberum multiovulatum, stylo corollam aequante, stigmatibus 2^{mm} longis. Baccae ignotae.

In sylvis humidis tenebrosis prope Zamorora, Depart. Santa Rosa, Guat., alt. 1800^{m}, Apr. 1893, *Heyde et Lux*, n. 4490 Pl. Guat. etc., qu. ed. Donn. Sm.

Psychotria Suerrensis Donn. Sm.—Stipulae utrinque binae remotae setoso-lineares. Folia brevissime petiolata oblongo-elliptica longe acuminata basi acuta aut acuminata glaberrima. Cyma pedunculata glomeroso-contracta 4-ramea latior quam longior tota pubescens, bracteis foliaceis coloratis ab axillis remotis 1–3-nis ramos superantibus, floribus 1–4-aggregatis sessilibus bracteas subaequantibus. Calyx truncatus vix denticulatus.

Frutex orgyalis et ultra. Stipulae 4–5^{mm} longae in vaginam connatae. Folia pellucida, nascentia erubescentia, vetustiora 12–22^{cm} longa 4–9.5^{cm} lata, costa cum nervis lateralibus utrinsecus 9–11 valida et rubra, venis conspicuis, petiolis 5–7^{mm} longis. Pedunculus terminalis nonnunquam ex axillis supremis etiam ortus 1–3^{cm} longus. Cyma 2.5–4^{cm} lata, fructifera aucta, bracteis plerumque terminalibus et ternis pubescentibus primo erubescentibus denique violaceis oblongo-ellipticis 1–1.5^{cm} longis, fructiferis latioribus et 2^{cm} longis, floribus saepius 3-capitatis 4–5-meris pubescentibus in sicc. totis erubescentibus. Calycis pars superior ovario longior discum globosum aequans. Corolla (vivens) alba 12^{mm} longa, tubo lobis intus glabris 3-plo longiore supra medium intus pubescente ad $\frac{2}{3}$ longitudinis staminigero. Antherae subsessiles paulo infra mediam affixae lineares 3^{mm} longae inclusae. Stylus corollam aequans, lobis oblongis 2^{mm} longis. Drupa globosa diam. 4-millemetralis violacea pubescens 2-pyrena, seminibus dorso leviter sulcatis, albumine corneo.—Cum *P. contracta* Muell. Arg. collocare debetur.

In sylvis profundis Suerrensibus, Llanuras de Santa Clara, Cost., alt. 300^{m}, Febr. et Apr. 1896, *Donn. Sm.*, n. 6580 Pl. Guat. etc., qu. ed. Donn. Sm.—Eandem plantam invenit *Tonduz* prope Tsuritkub, Talamanca, Cost., Mart. 1894, n. 8683 herb. nat. Cost.

Lobelia fasciculata Donn. Sm. (§ HOLOPOGON Benth et Hook.) —Caulis decumbens foliis decurrentibus angulatus. Haec sessilia parva internodis longiora elliptica aut lanceolata evenia crenato-serrata. Pedunculi graciles, pedicellis paucis subumbellatim fasciculatis calyce longioribus. Calycis tubus oblique hemisphericus laciniis paulo brevior. Corollae unilabiatae tubus basi obliquus calyce aequilongus, lobi spathulato-obovati apice cuspidati, inferiores ceteris paulo majores quam tubus dimidio longiores. Antherae inclusae.

Glabrescens. Caulis 7–15^{cm} longus. Folia opaca supra pubescentia, inferiora 8^{mm} longa 4^{mm} lata, superiora 14^{mm} longa 4^{mm} lata. Pedunculi 2–3 circiter 5^{cm} longi. Inflorescentia cum calycibus pubescens. Pedicelli plerumque 5 circiter 5–8^{mm} longi bracteas lineari-lanceolatas serrulatas aequantes. Calycis tubus 3^{mm} altus, laciniae subulatae 4^{mm} longae serrulatae. Corollae lobi superiores 6^{mm} longi, inferiores 7^{mm} longi. Staminum tubus subliber, antheris 1^{mm} longis, omnibus vertice barbatis. Capsulae desunt.—Species alpina lobis corollinis insignis.

Todos Los Santos, Depart. Huehuetenango, Guat., alt. 3000^{m}, Sept. 1896, *Seler*, n. 3022.

Lobelia stolonifera Donn. Sm. (§ HEMIPOGON Benth et Hook.) —Glabra. Folia radicalia conferta petiolata spathulato-oblanceolata, caulina pauca prope basin sita amplexicaulia lineari-lanceolata. Caulis scapiformis ad apicem versus racemoso-pauciflorus. Corollae tubus lacinias calycinas vix aequans lobis propriis superioribus linearibus paulo brevior inferioribus obovatis dimidio brevior. Antherae minores setula unica appendiculatae.

Caulis assurgens 10–14^{cm} longus. Folia obscure dentata, radicalia petiolo adjecto 4–6^{cm} longa, caulina 1–2 circiter 2–3, 5^{cm} longa. Stolones filiformes 12–17^{cm} longi, foliis spathulato-obovatis sparsis ad apicem radicantem rosulatis. Racemus 3–4-florus, pedicello infimo 1–1, 5^{cm} longo bracteam foliaceam ciliatam aequante, pedicellis superioribus a bracteis superatis. Calycis tubus pubescens obovatus 3^{mm} altus, laciniae subulatae 5^{mm} longae. Corolla coerulea (cl. Seler in schedula), lobis inferioribus 8^{mm} longis. Staminum tubus liber, antheris subglabris subexsertis, majoribus 2^{mm} longis et vertice nudis. Capsulae non suppetunt.

Todos Los Santos, Chiantla, Depart. Huehuetenango, Guat., alt. 3000^{m}, Sept. 1896, *Seler*, 3017.

Macleania Turrialbana Donn. Sm.—Folia nascentia glandulari-punctata supra cum ramulis novellis pilosella, vetustiora glabra elliptica utrinque acuta aut obtusiuscula penninervia petiolati. Racemi folia superantes secundiflori, pedicellis supra basin bibracteatam articulatis et bibracteolatis. Calycis tubus teres. Corolla glabra staminibus bis paene longior. Antherae tubum aequantes.

Epiphyticus. Folia crasse coriacea 4–6^{cm} longa 2–3.5^{cm} lata, margine calloso, nervis lateralibus utrinsecus 4–5, petiolis corrugatis 4–9^{mm} longis. Racemi ex axillis superioribus orti 8–14-flori, fructiferi elongati et decurvi, bracteis bracteolisque semiorbicularibus acuminatis 2–2.5^{mm} longis margine puberulis, pedicellis crassis 12–18^{mm} longis ad $\frac{1}{3}$–$\frac{1}{5}$ longitudinis articulatis, floribus 5-meris. Calycis tubus campaniformis 5^{mm} altus, limbus patens 3^{mm} latus sinuato-dentatus. Corolla rosea succosa cylindracea subpentagona ad tertiam partem ampliata, lobis deltoideis 2^{mm} longis. Filamenta leviter cohaerentia 3^{mm} longa complanata, antheris paulo infra medium affixis tubo adjecto 10^{mm} longis. Discus annularis. Bacca globoso diam. 7-millemetralis vertice depressa, loculis 5 polyspermis, seminibus obovoideis.—Ab omnibus praeter *M. cordifoliam* Benth. speciebus adhuc cognitis inflorescentia racemosa differt.

Volcan de Turrialba, Cost., alt. 2600^{m}, Jan. 1899, *Pittier*, n. 7546 Pl. Guat., etc., qu. ed. Donn. Sm. (n. 13.090 herb. nat. Cost.).

BALTIMORE, Md.

(*To be concluded.*)

A CONSPECTUS OF THE GENUS LILIUM.

F. A. WAUGH.

(WITH FIGURES 1–14)

[*Concluded from p. 254.*]

28. L. OXYPETALUM Baker, Linn. Soc. Jour. **14**: 234. 1874.

Fritillaria oxypetala Royle, Ill. Bot. Him. 1. 388?. 1839.

Bulb oblong, with few lanceolate acuminate scales: stem slender, 3–4.5^{dm} tall: leaves 20–30, scattered, ascending, lanceolate or linear: perianth horizontal, wide funnel-shaped, 2.5–4^{cm} long, with oblong, acute segments, purplish tinged beneath with green, and dotted on the inner half of the upper surface, thickly papillose toward the center: stamens less than one third the length of the perianth; anthers purplish; filaments divergent: ovary clavate; style straight, shorter than the ovary.

Western Himalayas.

29. L. PAPILLIFERUM Franchet, Jour. Bot. **6**: 316. 1892.

Bulb small subglobose, with 10–12 thick ovate scales, closely imbricated: stem nearly 3^{dm} in height, densely clothed with short hairs, leafless for a considerable distance at the base: leaves scattered, the lower oblong-obtuse, the upper only half as large, linear, acute, all of them about 5-nerved, scabrous along nerves and margins: flowers one or two, nodding at the beginning of the summer, and becoming horizontal; perianth small, 5–6^{cm}, dirty red, short tubular at the lower part, with the segments subrevolute: filaments divergent, with anthers yellow: style a little longer than the ovary.

Yun-nan, China.

30. L. HENRYI Baker, Gard. Chron. III. **4**: 660. 1888.

Bulb globose, 5^{cm} in diam., outer scales ovate, fleshy: stem 6–10^{dm} long below the inflorescence: leaves subsessile, spreading, continued up to the very top; fully developed leaves lanceolate,

15–20 long, upper gradually smaller, uppermost ovate: inflorescence a lax corymb of 4–8 flowers, bracteate at base by a whorl of small ovate leaves: perianth yellow, 7.5–9^{cm} long; segments lanceolate, subobtuse, spreading from the middle, marked in the lower half with a few irregularly scattered brown spots: stamens equal the perianth segments; anthers linear: ovary subcylindric, 2.5^{cm} long; capsule oblong, obtusely angled.

Ichang, western China. Just coming into cultivation. Extremely thrifty and fine.

FIG. 6.—Lilium Henryi.

FIG. 7.—Lilium auratum.

31. L. AURATUM Lindl. Gard. Chron. **1862**: 640. July 12.

L. Dexteri Hovey, Mag. Hort. **1862**: 380.
L. Wittei Suring. in Koch, Wochens. **1867**: 294.

L. speciosum imperiale hort. Siebold in Baker, Linn. Soc. Jour. **14**: 235. 1874.

Bulb like *L. speciosum:* stem 6–12^{dm} high: leaves 20–30, scattered, very short petioled, glabrous, 5-nerved: flowers in a deltoid raceme with divaricate bracteolate pedicels; perianth large, wide-spreading, with segments much reflexed and somewhat twisted, white, more or less marked with bands of yellow and spots of purple, strongly papillose: anthers narrow; pollen red.

Several garden varieties have been described with botanical names. The most common have been included in the synonymy above. None deserves to rank as a botanical variety.

32. L. SPECIOSUM Thunb. Linn. Soc. Trans. **2**: 332. 1794.

FIG. 8.—Lilium speciosum.

L. superbum Thunb. Fl. Jap. 134. 1784. [non Linn.]
L. lancifolium hort. in Guill. Arch. Bot. **2**: 271. 1833.
L. Broussartii Morren, Acad. Roy. Brux. Mem. Feb. 1834.
L. eximium hort. in Kunth. Enum. Pl. **4**: 259. 1843.
L. punctatum hort. in Lem. Fl. d. Serr. I. **3**: 276. 1847.
L. vestale Mast. Gard. Chron. **1872**: 1522.
L. Tametomo Zucc. & Spae in Baker, Linn. Soc. Jour. **14**: 234. 1874.
L. Kratzeri Duch. in Baker. loc. cit.
L. Duchartrei.

Bulb perennial, globose, with lanceolate scales somewhat loosely imbricated: stem 6–12^{din} high, stiff: leaves 12–20, scattered, very short petiolate, oblong lanceolate, acute or acuminate, 5–7-nerved: flowers 3–10, racemose, on divaricate, bracteate pedicels, white more or less suffused with pink and dotted with red, strongly papillose toward the center; perianth segments

ovate lanceolate, much revolute: filaments much divergent: style slender, much curved; capsule obovoid, oblong, umbilicate.

Japan. One of the commonest and very best species in cultivation.

Var. RUBRUM hort. is a fine, extra strong growing sort, with darker pinkish-red flowers, and is the best for garden culture.

Var. ALBUM hort. (*L. praecox* hort.) is white or nearly so and less thrifty.

33. L. PUBERULUM Duch. Soc. Hort. Par. Jour. II. **4**: 217. 1870.

L. Canadense puberulum Torr. War Dept. Pac. R. R. Rpts. **4**: 146. part 5. 1856.

L. Californicum hort. in Duch. Soc. Hort. Par. Jour. II. **4**: 216. 1870.

L. Humboldtii Roezl & Leicht. in Duch. Soc. Hort. Par. Jour. II. **5**: 43. 1871.

L. Bloomerianum Kelogg, Cal. Acad. Proc. **4**: 60. 1872.

L. Bloomerianum ocellatum Kellogg, Cal. Acad. Proc. **5**: 88. 1872.

L. Robinsonianum hort. in Baker, Linn. Soc. Jour. **14**: 244. 1874.

FIG. 9.—Lilium puberulum.

Bulb large, thick, oblique, perennial, not bearing rhizomes, with few scales: stem 9–15^{dm} high: leaves in 4–6 large whorls of 10–15 leaves each, oblanceolate, acute: flowers 6–10 or more in a large panicle, on nodding divaricate pedicels; perianth 7.5–10^{cm} long, bright orange-red thickly marked with dark spots, with acute, strongly reflexed segments which are somewhat papillose at the base: style about one third the length of the ovary; capsule large, obovoid, acutely 6-angled.

California. A noble garden flower, not rare in cultivation.

34. L. MARTAGON Linn. Sp. Pl. 303. 1753.

L. hirsutum Mill. Dict. n. 10. [Ed. 8.]
L. Milleri Schultes Obs. Bot. 67.
L. verticillatum Gilib. Exercit. **2**: 466. 1792.
L. versicolor Salisb. Prod. 237. 1796.
L. glabrum Spreng. Syst. **2**: 62. 1825.
L. Cattaneæ Visiani Fl. Dalm. Suppl. 32. 1852.
L. Martagon dalmaticum Maly. in Baker, Linn. Soc. Jour. **14**: 245. 1874.
L. Martagonum St. Lag. Soc. Bot. Lyon Ann. **7**: 129. 1880.

Bulb perennial, ovoid, with very many narrow scales: stem 8–15^{dm} high: leaves several in 2–4-whorls of 6–9 leaves each, sometimes a few scattered or rarely all, oblanceolate, sessile, with 7–11 distinct nerves: flowers 3–20 in a long, loose, bracteate raceme, nodding, fragrant, varying in color from purple to dirty white, spotted, segments lanceolate, strongly revolute: pollen red: ovary shorter than the much curved style; capsule conical, acute angled, umbilicate.

FIG. 10.—Lilium maculatum.

Central and southern Europe, to Siberia and Japan. Long cultivated in gardens, especially in Europe, where it furnishes many cultural varieties.

35. L. MACULATUM Thunb. Linn. Soc. Trans. **2**: 334. 1794.

L. Hansoni Leicht. in Baker, Linn. Soc. Jour. **14**: 245. 1874.

Bulb perennial, globose, compact: stem 9–12^{dm} high: leaves oblanceolate, acute, frequently in a single whorl of 8–12 with some scattered, or sometimes several whorls: flowers 4–12 in a loose raceme, on erect-spreading pedicels, bright orange conspicuously spotted with purple on the lower half; perianth segments 2.5–5^{cm} long, thick, lanceolate,

wide spreading but scarcely revolute: anthers narrow; pollen yellow: ovary clavate, deeply furrowed.

Japan. Becoming very favorably known in cultivation.

36. L. SUPERBUM Linn. Sp. Pl. 434. 1762. [Ed. 2.]

L. Martagon Walt. Fl. Carol. 123. 1788.
L. Michauxii Lam. Ency. **3**: 457. 1789.
L. autumnale Lodd. Bot. Cab. **4**: *t.* 335. 1823.
L. Michauxianum Schultes f. Syst. Veg. **7**: 258. 1829.

Bulb perennial, large, globose, cespitose, with numerous acute, closely imbricated scales: stem 12–18^{dm} tall, erect: leaves often in whorls, sometimes more or less scattered, 3–5-nerved: flowers 6–12 or even more, paniculate, bright reddish-orange, conspicuously spotted: perianth segments 7.5–10^{cm} long, lanceolate, acute: filaments strongly diverging; anthers red: ovary a little shorter than the curved style; capsule obovoid.

FIG. 11.—Lilium superbum.

Canada to Georgia and west to the Mississippi river.

Var. CAROLINIANUM Chapm. Fl. S. States 484. 1860.

L. Carolinianum Michx. Fl. Bor. Am. **1**: 197. 1803.

Smaller, more slender, with fewer flowers and broader leaves.

A southern variety, in dry woods, Virginia to Florida and west to Louisiana.

37. L. OCCIDENTALE Purdy, Erythea **5**: 103. 1897.

Bulb shortly rhizomatous as in *L. pardalinum* but not branching as in that species, or forming clumps; scales overlapping closely:

stems 6–15^{dm} high: leaves scattering below but in whorls of 5–12 (or more) in the middle of the stem, lanceolate, acute, 5–10^{cm} long: flowers from a few to 15, umbellate or racemose; segments of perianth 3–6^{cm} long, the lower broadly lance-ovate, broadly overlapping at base, the upper two thirds revolute, at length to the pedicel; lower two thirds of segments light orange-red, thickly spotted with roundish black spots, upper one third a deep crimson: style straight, two thirds included in the tube: stamens little longer, spreading but little from the style; anthers oblong, 5^{cm} long, dark red.

California. "Most closely resembles *L. maritimum*, but its larger flowers with long revolute lobes strongly separate it from that species."—PURDY.

38. L. PARDALINUM Kellogg, Cal. Acad. Proc. **2**: 12. 1863.

FIG. 12.—Lilium pardalinum.

L. Washingtonianum Domb. Fl. Mag. *t. 33*. 1872.

L. Californicum Domb. Fl. Mag. textu sub *t. 33*. 1872.

L. Canadense pardalinum Bolander, Cal. Acad. Proc. **5**: 206. 1872.

L. Canadense Californicum Bolander, loc. cit.

L. pardalinum pallidifolium Baker, Linn. Soc. Jour. **14**: 242. 1874.

L. puberulum hort. Leicht. in Baker, loc. cit.

L. pardalinum Bourgæi Baker, loc. cit.

L. Warei hort. in Purdy, Calif. Florist **2**: 67. 1889.

Bulb short rhizomatous, with few, loose, lanceolate, acute scales: stem 6–12^{dm} high: leaves mostly near the middle of the stem in 3–4 whorls of 9–12 leaves each, with a few scattered: flowers 3–10, loose corymbose, on long, nodding pedicels, bright red with orange toward the center, strikingly marked with large purplish-brown spots; perianth segment 5–6^{cm} long, lanceolate, strongly revolute, somewhat papillose: stamens short; anthers

red: style scarcely longer than ovary; capsule oblong, acute angled.

California.

Var. ANGUSTIFOLIUM Kellogg in Wats. Am. Acad. Proc. **14**:258. 1879.

L. Rœzli Regel, Gartenfl. 321. *t.* 667. 1870.
L. Canadense Hartwegi Baker, Gard. Chron. **1871**: 321.

A form with narrow scattered leaves.

39. L. COLUMBIANUM hort. in Gard. Chron. **1871**: 1257.

L. Canadense parviflorum Hook. Fl. Bor. Am. **2**: 181. 1840.
L. Sayi Nutt. in Duch. Hort. Soc. Par' Jour. II. **5**: 273. 1871.
L. lucidum Kellogg, Cal. Acad. Proc. **6**: 144. 1874.
L. parviflorum Holz. U. S. Nat. Herb. Cont. **3**:253. 1895.

Bulb perennial, ovoid, small, acute, with lanceolate scales: stem 4.5–9^{dm} high, slender: leaves few, mostly in whorls of four or five, the upper ones frequently scattered, oblanceolate, acute, 4–5^{cm} long: flowers two or three or more, umbellate, on slender nodding pedicels; perianth 4–5^{cm} long, bright orange thickly spotted with small purplish dots, segments lanceolate, reflexed: stamens less than one third the length of the perianth: style scarcely longer than ovary.

Oregon, Washington. Not uncommon in garden collections, where it succeeds fairly well.

40. L. TALIENSE Franchet, Jour. Bot. **6**: 319. 1892.

Slender, nearly 1^{m} high: stem thinly papillose-scabrous, leafless for a considerable distance near the ground: leaves slightly crowded, linear or narrow linear-lanceolate, obtuse or very acute, scattered, upper ones opposite or whorled, all 1-nerved with the margins very rough, narrowed for a long distance at the base: flowers one or two, whitish, spotted or unspotted; perianth very similar to *L. Lankongense*, but the nectar furrow bare and very smooth.

Yun-nan, China.

41. L. LANKONGENSE Franchet, Jour. Bot. **6**: 317. 1892.

Stem 3–6^{dm} high, leafy almost to the ground: leaves narrow lanceolate, 5-nerved, scarcely scabrous along the nerves and margins, crowded, the lower ones wide at the base, half clasping, obtuse, those at the middle and upper parts a little longer, acute, and those at the upper part beneath the inflorescence 3–5-whorled: flowers one or more often two or three, on long peduncles nodding when they first come out; perianth white or purple, spotted with black, with the segments oblong, somewhat incurved above the base, open, nectar furrow papillose: stamens divergent, with yellow anthers: style two to three times longer than the ovary.

Yun-nan, China.

42. L. AVENACEUM Fischer in Regel, Gartenfl. **1865**: 290.

L. Martagon Ledeb. Fl. Ross. **4**: 149, ex parte, 1814.

Bulb globose, small, perennial, with very many lanceolate scales: stem 3–6^{dm} high: leaves few, scattered or somewhat whorled, oblanceolate, 7–10^{cm} long: flowers few, nodding, perianth small, 2.5–3.5^{cm} long, revolute, bright reddish-yellow, with a few fine dots, segments lanceolate: ovary half as long as the curved style.

Kamchatka, Manchuria, Kurile islands, Japan.

43. L. MONADELPHUM Bieb. Fl. Taur, **1**: 267. 1808.

L. Loddigesianum Schultes f. Syst. Veg. **7**: 416. 1829.

L. Szovitsianum Fisch. & Lall. Ind. Sem. Hort. Petrop. **6**: 58. 1839.

L. colchicum hort. in Planch. Fl. d. Serr. I. **5**: 507. 1849.

Bulb perennial, ovoid, with several lanceolate scales: stem 6–15^{dm} high: leaves 30–50, scattered, linear-lanceolate or oblanceolate, distinctly many-nerved: flowers 2–12, sometimes 20–30, in a raceme, nodding, bracteate, fragrant, yellow, with a few small spots and tinged at the base and tip with purple; perianth segments 6–8^{cm} long, oblanceolate, recurved from the middle, smooth at the base inside: pollen red: ovary half as long as the style; capsule obovoid, umbilicate.

Persia.

Var. LEDEBOURI Baker, Linn. Soc. Jour. **14**: 246. 1874.

L. pyreniacum Led. (non Gouan.) Fl. Ross. **4**: 151. 1814.

L. Ledebourii Boiss. Fl. Orient. **5**: 175. 1867.

Caucasus. Dwarfer than the species, with narrower linear leaves.

44. P. POLYPHYLLUM D. Don in Royle, Ill. Bot. Him. 388. 1839.

L. punctatum Jaquem. in Duch. Soc. Hort. Par. Jour. II. **4**: 545. 1870.

Stem 9–12^{dm} high: leaves 40–60, scattered, ascending, the lower oblanceolate, 10–13^{cm}, the upper narrower and linear: flowers 4–10, in a loose raceme, on nodding pedicels, bright yellow with vinous purple spots, fragrant; segments of the perianth 4–5^{cm} long, oblanceolate, revolute from the middle: ovary two thirds as long as the much curved style; capsule obovoid.

Western Himalayas.

45. L. CARNIOLICUM Bernh. in Mert. & Koch. Deutsch. Fl. **2**: 536. 1838?

L. Chalcedonicum Linn. Sp. Pl. 434, ex parte, 1762. [Ed. 2.]

L. alpinum Kit. (?), Linnæa **32**: 335. 1863.

L. Ponticum K. Koch(?), Linnæa **22**: 234. 1849.

Bulb perennial, ovoid, with several lanceolate scales: stem 6–9^{dm} high: leaves 30–40, scattered, lanceolate or linear-lanceolate, the lower 5–7.5^{cm} long, flat, distinctly many-nerved, with ciliate margins: flowers in a small raceme, nodding; perianth 4–5^{cm} long, orange or red, with minute spots, with lanceolate sharply revolute segments which are papillose toward the base: pollen yellow: ovary equaling the clavate style; capsule 4^{cm} long, obtuse angled.

Southern Europe. A fine species, but rare in cultivation.

46. L. MAXIMOWICZII Regel, Ind. Sem. Hort. Petrop. **1866**: 26.

L. Leichtlini Hook. f. Bot. Mag. *t. 5673*. 1867.

L. pseudo-tigrinum Carr. Rev. Hort. **39**: 411. 1867.

L. Leichtlini majus Wils. Jour. Hort. **1873**: 371.

L. jucundum hort. Bull in Elwes Mon. Gen. Lil. *t. 40*. 1877.

Bulb perennial, globose, small, with few, wide, acute, thick, closely imbricated scales: stem 6–9^{dm} high, slender, decumbent at the base: leaves 30–40, scattered, linear, ascending, flat,

3-nerved: flowers few, in a loose corymb, on spreading pedicels, either bright lemon-yellow, light orange or red, thickly dotted with dark purple, and tinged with purple on the outside; segments lanceolate, 5–7.5^{cm} long, strongly revolute, thickened at the tip: anthers reddish-brown: ovary slender, one third the length of the curved style.

Japan. There are several good garden varieties, but none deserving the distinction of a botanical name.

47. L. TESTACEUM Lindl. Bot. Reg. Misc. **1842**: 51.

L. Isabellinum Kunze in Mohl & Schlecht. Bot. Zeit. 1: 609. 1843.
L. peregrinum hort. Germ. in Lem. Fl. d. Serr. I. 1: 192. 1845.
L. excelsum hort. in Seem. in Harting Parad. Vindob. 2. 1845 cir.
L. altissimum hort. in Duch. Soc. Hort. Par. Jour. II. 4: 215. 1870.

Bulb perennial, globose: stem 1.5–2^{m} high: leaves 60–100, scattered, linear, ascending, 3–5-nerved, the lower ones 7.5–10^{cm} long, gradually becoming smaller upward: flowers 2–10, umbellate, nodding, fragrant, creamy-yellow, with sometimes a few minute reddish dots, slightly papillose; perianth segments 6–7.5^{cm} long, strongly revolute: filaments half as long as the perianth; pollen red: ovary a little more than half as long as the curved style.

Not known in the wild state, and thought to be a hybrid. A fine, stately plant, with delicate, pretty flowers.

48. L. OCHRACEUM Franchet, Jour. Bot. **6**: 319. 1892.

Bulb small, with few fine lanceolate scales: stem slender, 9–12^{dm} high, bare for a long distance at the base: leaves crowded at the middle, smooth, 1-nerved, or the lower ones slightly 3-nerved, narrowed at the base, subpetiolate, linear-lanceolate or lanceolate, acute or acuminate, all scattered: flowers 1–3, at first nodding, spotted with yellow; perianth tubular for one-third its height, segments oblong, incurved subrevolute; nectar furrow bare, smooth: stamens less than half as long as the perianth; anthers yellow: style three times as long as the ovary.

Yun-nan, China.

49. L. FARGESI Franchet, Jour. Bot. **6**: 317. 1892.

Bulb ovate, small, with 10–15 fleshy scales: stem slender,

3–10[dm] high, leafless below, then leaves somewhat crowded, linear, with margins narrowly revolute: flowers sometimes solitary, sometimes 2–10 in a pyramidal raceme, all with long peduncles at the axils of the persistent leaves, nodding when young, horizontal when fully flowered, or nearly erect; perianth small, 4–5[cm] long, yellow, thickly spotted with purple on the inside, and smooth without; segments lanceolate, immediately expanded, then recurved the whole length, with several fimbriate crests running parallel with the nectar furrow, which is papillose: stamens half the length of the perianth; pollen yellow: style a little longer than the ovary; capsule ovate or nearly square, truncate at the top.

Su-tchuen, China.

50. L. POMPONIUM Linn. Sp. Pl. 302. 1753.

L. angustifolium Miller, Dict. n. 6. 1768. [Ed. 8.]

L. rubrum LaM. & DC. Fl. Fr. 213. 1805. [Ed. 3.]

Bulb perennial, ovoid, with several lanceolate scales: stem 6–9[dm] high, thick, stiff: leaves 100 or more, scattered, narrow linear, ascending, the lower ones 5–10[cm] long, the upper ones shorter and narrow linear: flowers 2–15, racemose, nodding, often bracteolate, cinnabar-red, thickly spotted and papillose within, fragrant; perianth segments 4–5[cm] long, oblanceolate, wide: pollen red: ovary a little shorter than the style; capsule obovoid, umbilicate.

FIG. 13.—Lilium pomponium.

Northern Italy and southern France. An excellent lily for garden planting, especially the yellow *L. pomponium aureum* hort.

Var. PYRENAICUM Baker, Linn. Soc. Jour. **14**: 249. 1874.

L. Pyrenaicum Gouan, Ill. 25. 1773.

L. flavum Lam. & DC. Fl. Fr. 213. 1805. [Ed. 3.]

Pyrenees. A more robust plant, with wider leaves distinctly 3-nerved; flowers larger, yellow.

51. L. CHALCEDONICUM Linn. Sp. Pl. 302, ex parte, 1753.

L. miniatum Salisb. Prod. 237. 1796.

L. pomponium DC. in Red. Lil. *t.* 7. 1802–16.

L. Pyreniacum Baumg. (non Gouan.) Enum. Stirp. Transyl. **1**: 301. 1816–46.

L. noricum Bernh. in Steud. Nom. ed. ii, **2**: 44. 1840.

L. gracile Ebel, Zwölfe Tage auf Montenegro 8. 1842.

L. Albanicum Griseb. Spicil. Fl. Rumel. **2**: 385. 1844.

L. Byzantinum hort. in Duch. Soc. Hort. Par. Jour. II. **5**: 280. 1871.

L. Jankae Kern. in Oestr. Bot. Zeitschr. **27**: 402. 1877.

L. Heldreichii Freyn. Flora **63**: 28. 1880.

Bulb perennial, ovoid, with several lanceolate scales: stem 9–12^{dm} high, stiff: leaves 100 or more, crowded, ascending, 3–5-nerved, with the edges and veins on the lower side distinctly papillose: flowers few, in a raceme, with nodding peduncles; perianth 4–5^{cm} long, bright red, unspotted, or sometimes with minute dots, rarely yellow; segments oblanceolate, much revolute, abundantly papillose: ovary nearly as long as the style.

Greece. A very excellent garden plant.

52. L. CALLOSUM Sieb. & Zucc. Fl. Jap. **9**: 86, *t.* 41. 1835.

L. pomponium Thunb. (non Linn.) Fl. Jap. 134. 1784.

Bulb small, perennial, with few lanceolate scales: stem 3–9^{dm} high: leaves 30–40, scattered, linear, 3–5-nerved, edges narrowly revolute: flowers 2–12 in a narrow loose raceme, on short nodding pedicels; perianth 2.5–3.8^{cm} long, bright scarlet: filaments short, with scarlet anthers: ovary as long as the clavate style; capsule ovoid.

Japan and the Loo-choo islands.

53. L. SUTCHUENSE Franchet, Jour. Bot. **6**: 318. 1892.

L. tenuifolium punctatum Bur. & Franch. in Franch. loc. cit.
L. Chinense Baroni, Nuov. Giorn. Bot. It. **2**: 333. 1895.
L. Chinense atropurpureum Baroni, op. cit. 335.
L. Biondii Baroni, op. cit. 337.

Bulb small, broad ovate, scales fleshy, ovate-lanceolate, about 15–18 imbricate: stem slender, 8–10^{dm} high, leafless below: leaves scattered, only slightly crowded, linear, the lower and upper ones one third the length of the others, those in the middle 10–15^{cm} long, smooth: flowers solitary, or terminating 2–4 long stiff branches, nearly erect when young; perianth intensely reddish-orange, often spotted with black; segments much recurved from the middle, papillose on the inside: stamens shorter than the perianth, with the filaments smooth and the pollen golden: style 3–4 times as long as the ovary.

Su-tchuen, China. Shen-si, *legit* Giraldi, *fide* Baroni. "The plant is more robust than *L. tenuifolium*, the leaves equally linear but a little larger, flowers almost twice as large, covered with black spots, style two or three times longer than the ovary."—Franchet.

54. L. TENUIFOLIUM Fisch. Ind. Sem. Hort. Gorenk. 8. 1812. [Ed. 2.]

L. linifolium Hornem. Hort. Hafn. **1**: 326. 1813.
L. pumilum DC. in Red. Lil. *t. 378*. 1815 cir.
L. puniceum Sieb. & DeVriese. Ann. Hort. Pays-Bas 23. 1861.
L. tenuifolium stenophyllum Baker, Linn. Soc. Jour. **14**: 251. 1874.

Bulb small, globose, with several lanceolate scales: stem 3–6^{dm} high, slender: leaves 20–50, scattered, very narrow linear, ascending, with revolute margins: flowers 1–20, racemose, on nodding pedicels 5–7.5^{cm} long, rich scarlet, unspotted; perianth segments 2.5–5^{cm} long, much revolute: pollen red: ovary two thirds as long as the slender style.

Siberia. A deserving favorite in gardening, growing readily from seeds or from bulb scales.

55. L. BOLANDERI Wats. Am. Acad. Proc. **20**: 377. 1885.

Bulb ovate, of numerous lanceolate scales 2.5–3.5^{cm} long: stems 15–90^{cm} high, 1–2-flowered: leaves mostly verticillate and

approximate, oblanceolate, acute, glaucous beneath: flowers horizontal or somewhat nodding, dingy purple or dark brownish-red, becoming somewhat paler, spotted; the segments 3–4^{cm} long, but slightly spreading, rarely at all recurved: anthers 4–6^{mm} long: ovary and style 18–20^{mm} long.

In Red Hills, Humboldt county, California, by Bolander, near Arcata; between Illinois and Smith rivers near state boundary. Allied to *L. parvum* and *L. maritimum*. Rare.

56. L. GRAYI Wats. Am. Acad. Proc. **14**: 256. 1879.

FIG. 14.—Lilium parvum.

Leaves lanceolate, 5^{cm} long or less, in whorls of 4 to 8, not acuminate: flowers 4–6^{cm} long, horizontal, often solitary; segments spreading but not recurved, deep reddish-orange, covered throughout with purplish spots.

Virginia and North Carolina. Becoming somewhat common in cultivation. Closely related to *L. Canadense*.

57. L. PARVUM Kellogg, Cal. Acad. Proc. **2**: 179. 1863.

L. Canadense Walkeri Wood. Phil. Acad. Proc. **1868**: 166.

L. Canadense parvum Baker, Linn. Soc. Jour. **14**: 241. 1874.

L. parvum luteum Purdy, Erythea **5**: 105. 1897.

Bulb of *L. Canadense*: stem 3–4.5^{dm} high: leaves partly whorled, or the upper ones scattered: flowers few to many, upright or nearly so, bright reddish-orange, thickly dotted; perianth segments 2.5–4^{cm} long, acute, more or less reflexed above the middle: ovary half as long as style.

Sierra Nevada mountains, California.

58. L. NITIDUM hort. Bull. in Baker, Gard. Chron. **1880**: 198.

Bulb oblong, subrhizomatous, with crowded, appressed, lanceolate scales: stem 4.5^{dm} long below the inflorescence, stout, bearing four whorls of leaves and several additional scattered ones: leaves up to 20 in a whorl, lanceolate: panicle deltoid, 15–25^{cm} long, of 10–20 flowers; lower pedicels 5–7.5^{cm} long, spreading with cernuous tips in the flowering stage, arcuate ascending in the fruiting stage; perianth bright yellow, with copious small red-brown dots, 4^{cm} long; segments lanceolate, under 13^{mm} broad, permanently connivent in the cup in the lower half, revolute in the upper half: filaments above 2.5^{cm} long; anthers oblong, bright yellow: ovary oblong, 13^{mm} long; style as long as the ovary, much curved.

This species is not known in our gardens, and is hardly represented in our herbaria. It should have further study.

59. L. MARITIMUM Kellogg, Cal. Acad. Proc. **6**: 140. 1874.

L. Canadense parviflorum Bolander in Wats. Am. Acad. Proc. **14**: 256. 1879.

Bulb small, conical: stem rather low: leaves usually scattered, narrow, often obtuse: flowers solitary or few, horizontal, 3–5^{cm} long, deep reddish-orange, spotted below: segments recurved above: style and stamens short; anthers 4^{mm} long: capsule long and narrow.

60. L. CANADENSE Linn. Sp. Pl. 303. 1753.

L. penduliflorum DC. in Red. Lil. *t. 105*. 1802–16.
L. pulchrum Salisb. Prod. 237. 1796.
L. pendulum Spae Mem. Gen. Lis. 28. 1845.
L. Canadense minus Wood, Phil. Acad. Proc. **1868**: 166.

Bulb annual, rhizomatous, with short, thick, obtuse scales: stem 3–12^{dm} high, slender, erect: leaves oblanceolate, acute, 7.5–10^{cm} long, 5–7-nerved, usually mostly in whorls: flowers one to several, somewhat umbellate; perianth 5–9^{cm} long, wide funnel-shaped, in various shades of yellow, orange and red with

numerous dark spots; segments oblanceolate, more or less revolute above the middle: filaments short: ovary a little shorter than the style; capsule conical.

Eastern North America from New Brunswick to Georgia, and west to the Mississippi river. A good species in cultivation. Varies considerably in degree of revoluteness and in color. Those with red flowers may take the name L. CANADENSE RUBRUM Britton (Torr. Bot. Bull. **17**: 125. 1890). Bright yellow sorts may be called L. CANADENSE FLAVUM hort. (nom. nov.).

61. L. PURDYI, nom. nov.

L. Bakeri Purdy, Erythea **5**: 104. 1897.

Bulb ovoid, exactly as in *L. Columbianum:* stem 6–18^{dm} high, rather stout: leaves lanceolate, mostly in whorls: inflorescence racemose; flowers few to ten, horizontal, orange-red, thickly dotted with maroon, very fragrant, buds nodding; segments of perianth 3^{cm} long, acute, lower half of segments forming a closely constricted tube from which upper half spreads rotately, tips not recurved: stamens exserted, a little shorter than the segments, not spreading much from the straight style, which they exceed a little.

Washington and British Columbia.

62. L. CORDIFOLIUM Thunb. Linn. Soc. Trans. **2**: 332. 1794.

Hemerocallis cordata Thunb. Fl. Jap. 143. 1784.
Saussurea cordifolia Salisb. Linn. Soc. Trans. **8**: 11. 1807.
L. Glehni F. Schmidt ? Reis. Amurl. 187 (Acad. Imp. Sci. St. Petr. Mem. xiii, no. 2). 1868.

Bulb perennial, globose, cespitose, with scales thicker, more rugose, and less regular than in *L. giganteum:* stem 9–12^{dm} high: leaves at the base cordate, long-petiolate, tinged with red, those on the stem cordate, ovate, petiolate: flowers 3–10, in a short raceme; perianth narrow, funnel-shaped, 10–15^{cm} long; segments oblanceolate, white, with large violet-brown patches on the lower half of the outer segments.

Japan. Sometimes seen in collections, but difficult of cultivation.

63. L. GIGANTEUM Wallich. Tent. Fl. Nep. 21, *t. 12–13*. 1824.

L. cordifolium D. Don. (non Thunb.) Prod. Nep. 52. 1825.

Bulb perennial, globose, cespitose: stem 1.5–3^{m} high: radical leaves green; cauline leaves 12–20, scattered, ovate, acute, deeply cordate at the base, reticulate veined, petiolate, gradually smaller above: flowers 12–20, in a raceme, slightly nodding, white, tinged with purple inside and green outside, fragrant, 12–15^{cm} long: stamens less than one-third the length of the perianth; anthers yellow: ovary cylindrical.

Himalayas. Found in large collections, but not generally successful in cultivation.

64. L. MIRABILE Franchet, Jour. Bot. **6**: 310. 1892.

Nearly 1.2^{m} high, slender: leaves thin, paperlike, unspotted, all alternate, cordate, broad, ovate, acuminate: inflorescence centrifugal: flowers 7–15, nearly horizontal; perianth white, tinged with violet on the margins outside, narrowly tubular, the tips moderately opened, 16–18^{cm} long, with the segments oblong-linear, much attenuated: stamens scarcely exceeding half the perianth, with short anthers and yellow pollen: ovary 2.5^{cm} long; style 6–7^{cm} long, slender.

Su-tchuen, China.

BURLINGTON, VERMONT.

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THE ECOLOGICAL RELATIONS OF THE VEGETATION ON THE SAND DUNES OF LAKE MICHIGAN.

HENRY CHANDLER COWLES.

[*Concluded from p. 308.*]

D. THE ESTABLISHED DUNES.

1. *The basswood-maple series.*

IT was shown in another place how the steep lee slopes of the slowly advancing dune-complex are first captured by social perennial herbs like Ammophila and Asclepias. Then shrubs like Cornus, Salix, and Prunus grow up and gradually drive out the herbs which grew there first, because they are ill-adapted to the shade. With these shrubs there often develop many young trees of the basswood, *Tilia Americana*. As these trees grow rapidly, it is not long before the thicket becomes a little forest, in which the dominant tree is the basswood. The basswood dune, more than any other type of established dune, is *sui generis*. It is to be found along the entire coast between Dune Park and Glen Haven.

The conditions that determine the development of the wonderfully characteristic flora are very obscure. The basswood dunes are always very steep and relatively near the lake. Unlike all other established dunes there is no approach to a vegetation carpet; the sandy soil is loose and bare and evidently more or less shifting. The movement of the sand is due directly to gravity and only indirectly to the wind. The only obvious condition which favors the rich development of plants is the almost complete protection from the wind.

The trees of the basswood dunes grow as thickly together as trees ever grow, and much more thickly than in any other dune forests. Everywhere the basswood is the dominant tree; no other tree begins to approach it in importance, although *Populus*

monilifera is often common. At the south end of the lake *Sassafras officinale* grows with the basswood in abundance. Trees that occur occasionally along the coast in this association are *Quercus coccinea tinctoria*, *Fraxinus Americana*, *Juglans cinerea*, *Ulmus fulva*, *Ostrya Virginica*, *Acer saccharinum*, *Betula papyrifera*, *Abies balsamea*, *Pinus Strobus*, *Tsuga Canadensis*, *Thuya occidentalis*.

One of the remarkable features of the basswood dunes is the luxuriant development of lianas. Scarcely anywhere away from the river bottom forests is there such a development of climbers in this region. *Celastrus scandens*, *Vitis cordifolia*, and *Rhus Toxicodendron* occur almost everywhere. *Ampelopsis quinquefolia* and *Smilax hispida* are not infrequent. The great liana development may be correlated, perhaps, with the dense growth of trees.

Shrubs are abundant about the margins of the miniature forests and in the more open places. Often these may be regarded as relicts of a former exclusive shrub vegetation. *Prunus Virginiana* and *Cornus stolonifera* are the most common tall shrubs, *Rosa Engelmanni* the most common low shrub. At the south end of the lake *Hamamelis Virginiana*, *Ptelea trifoliata*, *Rhus Canadensis*, and *Celtis occidentalis pumila* are common and very characteristic. The only herb that can be regarded as characteristic of this association is *Smilacina stellata*. *Elymus Canadensis* occurs in the open places. Many other herbs are occasionally present, but there is no necessity for mentioning them. The slopes of the crateriform depression in *fig. 22* have most of the typical plants of a basswood dune. The bare trees are chiefly basswoods, the others pines.

By all odds the most remarkable feature of the flora on the basswood dunes is its decided mesophytic flavor. The majority of the above-named species are usually pronounced mesophytes. Indeed, along the wooded bottoms of the Desplaines river far from dunes and dune influences, the following of the above plants may be found growing together: Tilia, Fraxinus, *Ulmus fulva*, Populus, Celastrus, Vitis, *Rhus Toxicodendron*, Ampelopsis, Smilax, Prunus, Cornus, Hamamelis, Ptelea, and Celtis. Thus half of the entire number recorded above are found in a single river

bottom forest. Of the fifteen most characteristic plants of the basswood dunes at the south end of the lake, eleven are found along the Desplaines bottoms; two of the remaining four, Sassafras and Smilacina, are common as mesophytes. Only two of the fifteen, *Rhus Canadensis*, and Rosa, are commonly xerophytic.

Apparently the life conditions on the basswood dunes are anything but similar to those of the river bottoms. The former appear to be xerophytic, the latter mesophytic and inclining to hydrophytic. The soil of the dunes is sand with scarcely any humus at all, and the slight water content is made less by the steepness of the slope. In the river bottom there is a deep alluvial soil rich with humus and with an abundance of water. Nor is the river bottom flora on the dunes the vanguard or the relict of a river bottom flora. At the south end of the lake, at least, the basswood dunes and river bottoms are separated from each other by many kilometers. The likeness of the floras suggests a likeness of conditions in the two apparently very dissimilar habitats. What this likeness is, if it exists at all, cannot easily be seen.

It is this river bottom flora on the dunes that furnishes the best examples of anatomical variation due to habitat conditions. Most remarkable gross variations are found in the leaves of nearly all the species. Celtis, a tall tree on the bottoms, is a thorny shrub on the dunes. The tissues, also, are highly modified so as to meet the requirements of the dune conditions. These great variations, not alone in a single species, but in a plant society transported, as it were, from the river bottoms to the dunes, will supply a large part of the material for the second or anatomical portion of this paper. It is also the author's intention to experiment with the river bottom and dune forms of the various species, and endeavor to determine whether or not these changes can take place within a single plant generation.

The development of an undergrowth of shrubs and herbs on the steep basswood dunes tends more and more to stop the sifting of the sand between the plants. The partial decay of the

FIG. 19.—Summit of a coniferous dune at Dune Park. The trees are white pines. The shrubs in front of them are junipers; those at the left, cedars. The grass in the foreground is Andropogon.

leaves which fall year after year gradually produces a humus. The conditions approach more and more those of the typical mesophytic forest, even though xerophytic dune societies may surround on every side. The growth of the humus permits the development of a low vegetation, consisting of lichens, mosses and forest herbs. The vegetation, shade, and humus conserve the water and cause a mesophytic soil in spite of the slope and sand. Seedlings of other trees, yet more indicative of the shady mesophytic forests than the basswood, make their appearance. The most prominent of these is the sugar maple, *Acer saccharinum*. Scarcely less important are the beech, *Fagus ferruginea*, and the hemlock, *Tsuga Canadensis*. These trees produce the densest shade and cause the extermination of the basswood and its associates. Each vegetation from the original Ammophila to the maple forest, therefore, gives a denser shade than the one preceding.

Accompanying the above-named trees are such typical mesophytic forest herbs as *Hepatica triloba*, *Trillium grandiflorum*, *Epiphegus Virginiana*, and *Arisaema triphyllum*. That the conditions not only in the soil but even in the air are less xerophytic than when the basswood was the dominant tree is shown by the great luxuriance of the vegetation. The trees are just as large as in inland forests and the xerophytic structures that were present in the basswoods and their associates are quite absent in the maples, beeches, and hemlocks. The air seems to be almost as mesophytic as in the inland forests. The maple and beech forests are not frequent on old dunes at the south end of the lake, but, for that matter, they are not so well-developed anywhere in this region as they are in Michigan. Mesophytic forests on old dunes were seen at Saugatuck, Grand Haven, Frankfort, and Charlevoix. At Frankfort there is a maple forest on the steep slope of an old dune which is as luxuriantly developed as in an inland location. At Charlevoix a hemlock was seen which had over 200 rings, showing the minimum length of time that the mesophytic flora could have existed on the dune. The mesophytic forest is the most permanent of plant societies

FIG. 20.—North slope of an oak dune at Dune Park, taken in winter, showing scattered pines among the oaks, and an abundance of pines at the lower levels.

in the lake region. It may be regarded as the culmination of the series which began with the lower beach.

2. *The evergreen series.*

a. The heath. — The life-history of a windward slope is vastly different from that which has just been described. If one views a region of established dunes from the lake side, he sees a landscape in which evergreens predominate, whereas a view from the land side often shows a decided dominance of deciduous trees. Not only the windward slopes but the summits have an evergreen flora. The key to these facts is exposure to desiccating factors, especially heat, cold, and winds. So far as the soil is concerned, there is but little difference between the conditions on the windward and leeward slopes. In both cases there is a vegetation carpet and a covering of humus. The more gentle slope favors the retention of moisture, though this factor is counterbalanced by the desiccating influence of the wind on the soil. At the south end of the lake the soil of the leeward slopes is drier than that of the windward slopes, because of the southern exposure and consequent drying influences of the sun. Even in this latter instance, the contrast between the floras of the two slopes is tremendous. It is the condition in the air, not the condition in the soil, which determines the difference here found. Both slopes have a mesophytic soil ; the leeward slope also has a mesophytic air, but the windward slope has a xerophytic air.

The heath has several origins but one destiny. It may arise on the slow-growing embryonic dunes, in depressions on the upper beach, on the fossil beach, on gravel terraces, or in pastures. In all cases the dominant plant species come to be one or more of the following : *Arctostaphylos Uva-ursi, Juniperus communis, Juniperus Sabina procumbens.* The first two are common along the entire coast, the latter only northward. The term heath has been but little used in America, perhaps because we do not have the peculiar Calluna heaths of Europe. The term heath, as here used, may be defined as a xerophytic flora in

which there is a dominance of low evergreen shrubs. Warming and Graebner use the term heath much more comprehensively, speaking of moss and lichen heaths and coniferous heaths. Along Lake Michigan the heath formation becomes more and more prominent northward. A well-marked juniper or bearberry heath is rare at the south end of the lake, while extensive

FIG. 21.—Rejuvenated dune on Beaver island. Wind-sweep at the center. Coniferous forests on each side that are not yet destroyed.

areas are covered by the heath on Beaver and North Maniton islands and on the neighboring mainland.

During the development of a heath, the vegetation partakes of the nature of the formation which preceded it, whether dune or beach or terrace. Before the true heath plants cover the soil, the open places are inhabited more or less abundantly by such plants as *Prunus pumila*, *Salix glaucophylla* and *adenophylla*, *Solidago humilis Gillmani* and *nemoralis*, *Aster laevis*, *Calamagrostis longifolia*, *Smilacina stellata*, *Lithospermum hirtum*, *Artemisia Canadensis*, *Rhus Toxicodendron*, *Rosa Engelmanni*. On fossil beaches

and terraces, embryonic heaths often have *Hudsonia tomentosa*, *Andropogon scoparius*, and *Campanula rotundifolia arctica* in addition to the above.

At the center of *fig. 6* there is shown a heath developing on a substratum of embryonic dunes; the bearberry has already covered a large portion of this area with a low heath carpet. *Fig. 24* shows the development of a heath on a fossil beach. In the foreground is a typical fossil beach flora, consisting of scattered grasses, sand cherries, etc. The small scattered tufts are Hudsonia. At the center is a low Ammophila dune, while back of this are patches of embryonic heath, composed of the bearberry and the procumbent juniper. Along the edge of the forest the heath forms a continuous carpet. *Fig. 25* shows a typical juniper heath when fully developed. At the left background the heath is younger and still made up of disconnected patches. *Fig. 26* shows the formation of a *Juniperus communis* heath in a pasture. Since this latter species is more or less erect, while the bearberry and procumbent juniper are creepers, the aspect of the heath shown in *fig. 26* is very different from those shown in *figs. 6* and *24*.

b. The coniferous forests.—Whatever the origin of the heath, it is rarely a climax type along the Lake Michigan shore. It almost uniformly develops into a coniferous forest sooner or later. The most conspicuous and extensive forests of this type are on the lakeward slopes, at the summit of these slopes, or at the summit of the taller inland dunes. These forests, like the heath, become more abundant and the growth more luxuriant as one passes northward along the lake shore.

The development of a forest from a heath is easy to understand and can be observed at almost all points. The heath vegetation is dense enough to prevent the tearing up of the soil by the wind, but not too dense for seedlings of various trees to get a start. The dense tangle of junipers and bearberries close to the soil is peculiarly well fitted to protect the trees while small and tender. In a very short time small and scattered trees become conspicuous on the heath. The transformation of a

FIG. 22.—Crateriform depression at Dune Park, within which are basswoods and pines in a state of considerable luxuriance. The slope in the foreground is the side of a deep wind-sweep; the development of this wind-sweep brings about the destruction of the flora through the action of gravity.

heath into a forest is illustrated by *figs. 24* and *25*. In each case the heath is encroaching on a beach and is being followed up *pari passu* by the forest. The advance of the heath is secured mainly by vegetative propagation, that of the forest by germination of seeds. This fact, together with the need for protection to the seedlings, prevents the forest from overtaking the heath in the struggle for more territory. So far as observed, the heath always precedes the forest, when the latter is developed in an exposed situation.

In the region as a whole, the pines are by all odds the character trees of the coniferous forests, and especially the white pine, *Pinus Strobus*. This tree is found at all places along the coast. At the south end of the lake the scrub pine, *Pinus Banksiana*, is more abundant than the white pine, while at the north end the red pine, *Pinus resinosa*, is often as frequent as the white pine. The distribution of the pines is very surprising. The scrub pine is the most northern of the three pines mentioned, and its farthest known southern limit is about the south end of Lake Michigan. Peculiarly enough, it is far more abundant than all other conifers put together at the south end of the lake, while it is much less abundant to the north along the lake shore. It was not seen at all north of Glen Haven, though it is reported as common inland. The red and white pines have in general a more southern range than the scrub pine, and yet they are more abundant northward along the lake than is the latter. Furthermore, these pines become more abundant absolutely as one goes northward. The red pine was not seen south of Pentwater.

North of Grand Haven *Thuya occidentalis* becomes a frequent member of the coniferous forests; sometimes it becomes as dominant as the pines. The same may be said of *Abies balsamea*, though it was not seen south of Frankfort. *Juniperus Virginiana* is frequent, especially southward. With the evergreens are occasional deciduous trees, especially at protected forest margins; among these are *Betula papyrifera*, *Tilia Americana*, *Populus monilifera*, and *Ostrya Virginica*.

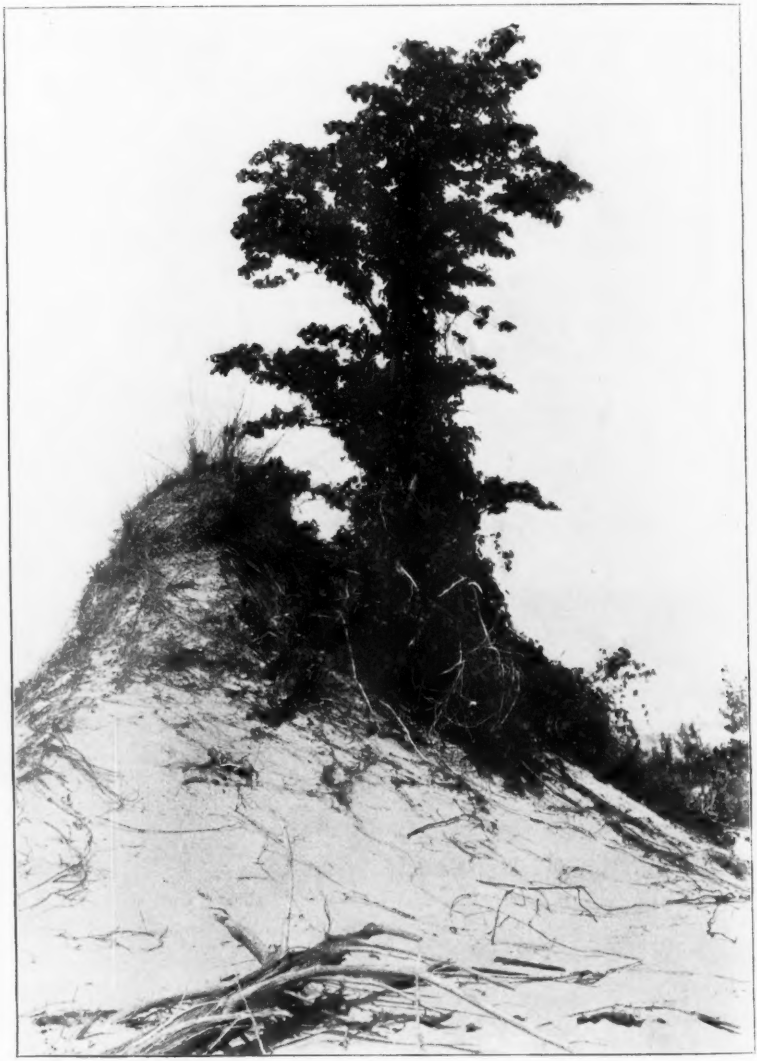

FIG. 23.—Rejuvenated dune at Dune Park. The basswood is the last remnant of a former forest. Clump of Calamagrostis at the left, showing the tenacity with which its roots hold the sand.

So long as the coniferous forests remain more or less open, the three dominant heath plants, *Arctostaphylos Uva-ursi*, *Juniperus communis*, and *J. Sabina procumbens*, retain their prominence. Of these Arctostaphylos is the most persistent, and may be regarded as the most characteristic plant of the forest undergrowth. There are occasional shrubs in the open places, such as *Shepherdia Canadensis*, *Diervilla trifida*, *Rosa Engelmanni*, *Prunus pumila*. Among the herbs in open places are *Calamagrostis longifolia*, *Aster laevis*, *Smilacina stellata*, *Arabis lyrata*, *Lithospermum hirtum*. Many mosses occur more or less shaded by the evergreens, especially Thuidium and other trailing varieties. *Fig. 19* shows a coniferous society at the summit of a dune. The trees are white pines; the shrubs in front of them, *Juniperus communis;* those at the left, *J. Virginiana*. The grass in the foreground is *Andropogon scoparius*. Coniferous forests on exposed slopes are shown in *figs. 6* and *21*.

The coniferous forests heretofore considered are chiefly on exposed slopes and summits. Sometimes there are coniferous forests farther inland developed on older and lower dunes. The protection here is greater and the air is less xerophytic. Extensive forests of this type were found between Frankfort and Empire and on Beaver island. The trees are chiefly pines or balsams just as before, but the evergreen undergrowth of junipers and bearberries is largely replaced by such plants as *Vaccinium Pennsylvanicum*, *V. Canadense*, *Epigaea repens*, *Gaultheria procumbens*, *Linnaea borealis*, *Melampyrum Americanum*, *Pteris aquilina*. In the more open and sterile places there is often a moss or lichen carpet, consisting largely of *Cladonia rangiferina* (or other Cladonia species) or *Polytrichum commune*. At the south end of the lake plant societies of this type become more like pine barrens. On the east coast of Beaver island there is a beautiful gradation series from the heath on the beach through a pine forest like that described in this paragraph into a pine forest in which there is almost no undergrowth at all. The scarcity of herbaceous or shrub vegetation is due to the dense shade and the carpet of pine needles. This last type is the summit of the

evergreen series, and is in all probability a climax type, at least in certain situations.

A very distinct type of coniferous forest is especially well developed at the south end of the lake. Since it is not developed in exposed situations, or even on old dunes, but in low depressions between dunes, it may be called a pine bottom. These societies are developed where the soil is almost hydrophytic. A common location for these miniature pine forests is about the gently sloping margin of an undrained swamp. *Figs. 9, 13, 14,* and *20* show them in such a situation. The line of demarcation between the sedge swamp and the pines is usually quite sharp. The surface of the soil where the pines grow may be less than a meter above the water level.

The character tree of the pine bottoms is always *Pinus Banksiana.* This species is, perhaps, less common than the white pine at the higher levels, but the white pine is rarely, if ever, present on the bottoms. No growth of trees anywhere in the dune region is so pure as the pine growth here. The most common shrubs in these locations are *Hypericum Kalmianum*, *Salix glaucophylla*, *Arctostaphylos Uva-ursi*, and *Juniperus communis*. *Linnaea borealis*, *Arabis lyrata*, *Fragaria Virginiana*, and species of Pyrola are frequent. The development of the pine bottom floras was seen at several points. One of the most interesting cases was in a region of oak dunes, where a railroad company had removed considerable sand and lowered the level several meters. Although surrounded on all sides by oaks and at some distance from a pine flora, the new flora at the lower level is developing into that of a pine bottom.

c. The rejuvenated dunes.—The instability of dune conditions is not confined to the dune-complex. The capture or establishment of a dune is liable to be stopped at any point and retrogression toward the active dune conditions instituted. Even a dune that has long been completely established may have its vegetation destroyed and pass again into a state of activity. This process may be called rejuvenation. Any dune may become rejuvenated if the physical conditions are favorable, but the

great majority of rejuvenated dunes are developed from established coniferous dunes; hence this type is discussed in connection with the evergreen series. The coniferous forests that develop on the windward slopes near the lake are peculiarly subject to destruction. The slightest change in the physical conditions is often sufficient to bring about the destruction of a

FIG. 24.—Beginnings of a heath on a fossil beach at North Manitou island. Grasses, sand cherries, and patches of Hudsonia in the foreground. Low Ammophila dune at the center. Patches of bearberry heath forming farther back. Advance of the coniferous forest out upon the heath.

coniferous society. The removal of a comparatively slight barrier may be enough to direct the entire wind energy against a pine forest.

The formation of a wind-sweep is, perhaps, the most common way for rejuvenation to begin. *Fig. 6* shows a windward slope tenanted by conifers that has become rejuvenated at three points. One of these wind-sweeps is seen at closer range in *fig. 21*. This latter sweep is forty-five meters in height, and the

angle of slope varies from twenty to thirty degrees. When once a sweep is formed the tendency to self-perpetuation becomes greater and greater, since the wind becomes more and more concentrated as the sweep grows deeper. The destruction of the forest vegetation is very soon accomplished at such a place. The desiccating influence of the wind becomes increased and

FIG. 25.—Juniper heath on North Manitou island. Young heath patches at the left background. Fully developed heath in the foreground. Advancing coniferous forest at the right background.

makes it difficult even for the xerophytic conifers to survive. At no place is the destructive action of the sand-blast seen so well as in these rejuvenated sweeps. The branches and even the trunks of the trees have the softer parts carved away, while the more resistant portions stand out in conspicuous relief. The leaves, especially of deciduous trees, are torn or withered or even altogether destroyed.

These destructive agencies are aided by another force that is altogether irresistible when the sweeps grow deeper, the force of

gravity. *Fig. 22* shows a plant society that is being destroyed mainly by gravity. The view is taken looking at the side of a deep gorge-like wind-sweep which the wind has cut. As the wind blows along, its energy increased by concentration, a large amount of sand is picked up along the base of the steep sides. The sand is as steep as it will lie, so that each removal causes a movement of the sand down the slope. The fallen trees shown in the photograph have been overturned and carried down the slope in just this way. That the direct action of the wind is also powerful enough to destroy without the assistance of gravity is proven by the dead but standing trees at the left, where the action of gravity happens to be much less.

Many plant species resist the process of dune rejuvenation to a surprisingly successful extent. *Fig. 23* shows the last remnant of a plant society that may have been somewhat extensive. The tree at the center is a basswood, a tree which could never develop in such an exposed situation. In all probability this mound is a fragment of a protected lee slope, on which the basswood grew and flourished for a time. The grass at the left is Calamagrostis; the tenacity with which it holds its ground has already been mentioned. Sometimes a group of cedars, *Juniperus Virginiana*, remain at the apex of a conical mound of sand, their associates having been swept away with the sand in which they grew. On the beach at Charlevoix there is a stranded clump of stunted trees of Thuya; they are probably the remnant of a society which has been otherwise destroyed.

As a wind-sweep is developed, and the evergreen vegetation destroyed, many plants that have been previously mentioned as characteristic of bare and exposed situations again make their appearance. The most prominent of these are *Artemisia Canadensis* (or *A. caudata*), *Elymus Canadensis*, *Solidago humilis Gillmani*, *Asclepias Cornuti*, *Œnothera biennis*, *Rosa Engelmanni*, *Calamagrostis longifolia*, *Prunus Virginiana*. In addition to these there come in, of course, the annuals and biennials mentioned in connection with the wind-sweeps on the dune-complex.

While rejuvenated dunes are to be found along the entire

coast, they reach their highest development northward, especially at the summit of the terraces and bluffs. Perched dunes, it would seem, are favorably located for destruction by the wind. At Frankfort and Empire the perched dunes are in the earlier stages of rejuvenation. At Glen Haven these dunes have been rejuvenated, the vegetation entirely destroyed, and the sand

FIG. 26.—Development of a juniper heath in a pasture at Beaver island.

removed inland to form the gigantic moving dunes previously mentioned. The substratum on which the dunes rested remains as a bare gravel mesa, with only the Sleeping Bear left to tell the tale of its former occupation by coniferous dunes. It is barely possible that some of these so-called rejuvenated dunes have never been established, and that they have grown slowly to their present height *pari passu* with the vegetation. This is purely a theory without any facts whatever to support it. The evidence seems to point unmistakably to an establishment followed by

rejuvenation. Evergreen vegetation is very poorly adapted for any *pari passu* growth, such as is found on the embryonic dunes.

3. *The oak dunes.*

At the south end of the lake, and as far up the eastern shore as Manistee, there may be seen old dunes covered over with rather open and scrubby oak forests. These dunes have long been established and are entirely free from the destructive sand-laden winds which are so influential in determining the character of the other dune societies. As a rule the oak dunes are low and are separated from the lake by several series of dunes on which the vegetation is less stable.

The dominant tree on the oak dunes is the black oak, *Quercus coccinea tinctoria*.[5] This tree is far more abundant than all others combined. The only other tree that may be called characteristic in the Dune Park region is *Quercus alba*. On some oak dunes there are low trees or tall shrubs of *Sassafras officinale*, *Cornus florida*, *Amelanchier Canadensis*, and *Hamamelis Virginiana*. The characteristic shrubs are comparatively few except along the lower margins toward the swamp level, or on shaded northern slopes. The most abundant shrubs are *Vaccinium vacillans* and *V. Pennsylvanicum*, *Salix humilis*, *Viburnum acerifolium*, *Rosa blanda* and *R. humilis*, and *Rhus copallina*.

The herbaceous vegetation of the oak dunes is very diversified and interesting. The trees are always far enough apart to permit an extensive undergrowth of relatively light-loving plants. On the southern slopes, where there is considerable exposure to the sun, there is rarely a continuous vegetation carpet, but a more or less tufted vegetation with intervening patches of naked sand. A large number of herbs are characteristic of such places, for example: *Pteris aquilina*, *Koeleria cristata*, *Cyperus Schweinitzii*, *Carex Pennsylvanica*, *C. umbellata*, *C. Muhlenbergii*, *Tradescantia Virginica*, *Arabis lyrata*, *Lupinus perennis*, *Tephrosia Virginiana*, *Les-*

[5] The closely related *Quercus rubra* and *Q. coccinea* occur commonly in neighboring plant societies and may be present on the dunes, as may hybrids between any of the three forms here mentioned.

pedeza capitata, Euphorbia corollata, Helianthemum Canadense, Viola pedata, Opuntia Rafinesquii, Œnothera rhombipetala, Monarda punctata, Aster linariifolius, Helianthus divaricatus. In very open places there are various species of Geaster and Lycoperdon, *Festuca tenella, Polygonum tenue, Polygonella articulata, Talinum teretifolium, Mollugo verticillata, Draba Caroliniana, Linaria Canadensis, Krigia Virginica.*

On the shaded northern slopes *Pinus Banksiana* and *Pinus Strobus* often occur with the oaks (see *fig. 20*). The undergrowth is often a complete vegetation carpet, and consists of Vaccinium, Viburnum, and others of the above plants, together with many different forms. Among the plants here there may be mentioned various species of Cladonia and Peltigera, several mosses, *Aquilegia Canadensis, Epigaea repens, Phlox pilosa.*

In the background of *fig. 9* there may be seen several oak dunes. The view was taken in the winter and shows a dominance of oaks, but the scrub pines are scattered here and there on northern slopes or in exposed situations. *Fig. 11* shows the advance of an active dune on the north slope of an oak dune with a wealth of oaks and a few scattered pines. *Fig. 20* is a view looking upon the north slope of an oak dune (taken in winter). The pines are abundant at the base and scattered on the slope. A view of the south slope would show no pines at all.

The conditions for the origin and development of an oak dune flora are obscure. At Grand Haven and Ludington the oak flora appears to follow the basswood flora. Remnants of the basswood flora are conspicuous in both places: Sassafras, Hamamelis, Vitis, Smilacina, *Rhus Toxicodendron*, Smilax, Celastrus. It may be that where the conditions are most favorable a maple forest develops after the basswood, but the oak forest elsewhere. At any rate the maple forests are more prevalent northward and the oak forests southward. While the oak forests at Grand Haven, Ludington, and Manistee are on steep, long-established lee slopes, the oak forests at the south end of the lake are often on rather low ridges, where the basswood may never have prevailed.

Quite probably the pine is the normal predecessor of the oak. The scattered pine trees shown in *figs. 9* and *20* may be the relicts of a more extensive pine flora that has been succeeded by the oaks. The oak cannot get a foothold until the dune has become well established and protected from the lake winds. If the pines are scattered, there is opportunity for the oak seedlings to develop successfully. Forest fires are more destructive to the pines than to the oaks; the former are more readily burned, and basal sprouts are less likely to appear afterward than in the case of the oaks. Near Dune Park there is a tract on which the pines have been burned and replaced by the oaks.

One of the most striking landscape features of the Dune Park region is the appearance of the pines at the lower levels (pine bottoms), and again on the highest summits. The oaks occupy an intermediate position as to altitude. The reason for this distribution seems to be that the pines have a much wider range of life conditions than the oaks. The oaks are excluded from the summits because of the extreme exposure to wind and cold; they are not xerophytic enough for such a habitat. They are excluded from the bottoms, because the conditions are too hydrophytic for them there. The pines are excluded from the intermediate positions not because of lack of adaptation, but because the oaks are better adapted for that position than are the pines. Where the oaks can live at all, they seem able to drive out the pines, while the pines occupy areas that are not adapted to the oaks.

The flora of the oak dunes, especially that found on sunny southern slopes, is a true xerophytic flora, but a xerophytic flora resembling that of the more southern type, where the adaptations are developed to protect against heat and the excessive transpiration which it causes. The flora on northern and windward slopes is predominantly evergreen, developing into a heath or a coniferous forest. This flora, too, is xerophytic, but of an arctic or alpine type, where the adaptations are developed to protect against the wind and cold and the dangers of excessive transpiration which they bring. The correctness of this view is

shown by studying the floras of the oak and pine dunes. The former has a flora related to those farther south, containing Opuntia, Euphorbia, and many other plants of southern range. The pine dunes, on the other hand, show the farthest southern limits of many northern plants—for example, the scrub pine itself. Linnaea, the bearberry, and many others have a northern range.

V. Conclusion.

No attempt will be made to summarize the results of this study, but a few of the more striking phenomena of the Lake Michigan dunes and their vegetation will be given. The dunes have been determined in the main by westerly winds. The great majority of the dunes are established, and many of them are perched high up on bluffs. The vegetation is xerophytic, belonging either to the arctic or desert type.

The xerophytic beaches are subdivided into three zones: the lower beach which is washed by summer waves and is essentially devoid of life; the middle beach which is washed by winter waves and is inhabited only by succulent annuals; the upper beach which is beyond present wave action and is inhabited also by biennials and perennials. There are also fossil beaches and gravel terraces with a flora resembling that of the upper beach, but less xerophytic.

Perennial plants are necessary for any extensive dune formation on the beach, since they alone furnish growing obstacles. Such plants must be pronounced xerophytes and be able to endure covering or uncovering. The most successful dune-formers are *Ammophila arundinacea*, *Agropyrum dasystachyum*, *Elymus Canadensis*, *Salix glaucophylla* and *S. adenophylla*, *Prunus pumila*, *Populus monilifera*. Ammophila and Agropyrum form low dunes that have a large area, because of their extensive rhizome propagation. The Elymus dunes do not increase in area since rhizome propagation is absent. The Salix dunes increase both in area and height, because of extensive horizontal and vertical growth. The Populus dunes are the highest and steepest, since the cottonwoods grow quite tall, but do not spread horizontally.

Small dunes are formed in more protected places by plants that are unable to exist on the beach, or where there is rapid dune formation. Among these secondary dune-formers are Andropogon, Arctostaphylos, Juniperus. Primary embryonic dunes may pass gradually into this second type, as this latter passes into the heath.

The stationary embryonic dunes on the beach begin to wander as soon as the conditions become too severe for the dune-forming plants. The first result of this change is seen in the reshaping of the dune to correspond with the contour of a purely wind-made form. The rapidity of this process is largely determined by the success or failure of the dune-formers as dune-holders. The best dune-holders are Calamagrostis, Ammophila, and Prunus.

There are all gradations between a simple moving dune and a moving landscape; the latter may be called a dune-complex. The complex is a restless maze, advancing as a whole in one direction, but with individual portions advancing in all directions. It shows all stages of dune development and is forever changing. The windward slopes are gentle and are furrowed by the wind, as it sweeps along; the lee slopes are much steeper. The only plant that flourishes everywhere on the complex is the succulent annual, *Corispermum hyssopifolium*, although *Populus monilifera* is frequent. The scanty flora is not due to the lack of water in the soil, but to the instability of the soil and to the xerophytic air.

The influence of an encroaching dune upon a preexisting flora varies with the rate of advance, the height of the dune above the country on which it encroaches, and the nature of the vegetation. The burial of forests is a common phenomenon. The dominant forest trees in the path of advancing dunes are *Pinus Banksiana*, *Quercus coccinea tinctoria*, and *Acer saccharinum*. All of these trees are destroyed long before they are completely buried. The dead trees may be uncovered later, as the dune passes on beyond.

In the Dune Park region there are a number of swamps upon

which dunes are advancing. While most of the vegetation is destroyed at once, *Salix glaucophylla*, *S. adenophylla*, and *Cornus stolonifera* are able to adapt themselves to the new conditions, by elongating their stems and sending out roots from the buried portions. Thus hydrophytic shrubs are better able to meet the dune's advance successfully than any other plants. The water relations of these plants, however, are not rapidly altered in the new conditions. It may be, too, that these shrubs have adapted themselves to an essentially xerophytic life through living in undrained swamps. Again it may be true that inhabitants of undrained swamps are better able to withstand a partial burial than are other plants.

Vegetation appears to be unable to capture a rapidly moving dune. While many plants can grow even on rapidly advancing slopes, they do not succeed in stopping the dune. The movement of a dune is checked chiefly by a decrease in the available wind energy, due to increasing distance from the lake or to barriers. A slowly advancing slope is soon captured by plants, because they have a power of vertical growth greater than the vertical component of advance. Vegetation commonly gets its first foothold at the base of lee slopes about the outer margin of the complex, because of soil moisture and protection from the wind. The plants tend to creep up the slopes by vegetative propagation. Antecedent and subsequent vegetation work together toward the common end. Where there is no antecedent vegetation, Ammophila and other herbs first appear, and then a dense shrub growth of Cornus, Salix, *Vitis cordifolia*, and *Prunus Virginiana*. Capture may also begin within the complex, especially in protected depressions, where *Salix longifolia* is often abundant.

Tilia Americana develops rapidly on the captured lee slopes, and the thicket is transformed into a forest. The trees grow densely, and there is little or no vegetation carpet. Associated with Tilia is a remarkable collection of river bottom plants, so that the flora as a whole has a decided mesophytic cast. These plants have developed xerophytic structures that are not present in the river bottoms. Acer and Fagus succeed Tilia and repre-

sent the normal climax type of the lake region, the deciduous forest.

On the established windward slopes the development is quite different from that described above. There is a dominance of evergreens instead of deciduous vegetation. The soil conditions are nearly alike on the two slopes, but the air is more xerophytic on the windward slopes. The evergreen flora starts as a heath formed of Arctostaphylos, *Juniperus communis*, and *J. Sabina procumbens*. The heath arises on fossil beaches, secondary embryonic dunes, or wherever the wind is relatively inactive and where the conditions are too xerophytic for the development of a deciduous flora. Before long the heath passes into a coniferous forest, in which *Pinus Banksiana*, *P. Strobus*, or *P. resinosa* dominate. Coniferous forests also occur on sterile barrens and in bottoms, where the conditions are also unfavorable for deciduous forests. A slight change in the physical conditions may bring about the rejuvenation of the coniferous dunes, because of their exposed situation. Rejuvenation commonly begins by the formation of a wind-sweep; the vegetation on either hand is forced to succumb to sand-blast action and gravity.

The evergreen floras are more and more common northward, while to the south there are developed forests in which *Quercus coccinea tinctoria* prevails. The oak forests are more common on inland dunes and on southern slopes. The oaks may follow the pines, when the areas occupied by pines become sufficiently protected from cold winds. The pines have a much wider range of life conditions than the oaks, since they appear at lower levels, higher levels, and on northern or windward slopes. The oaks flourish best on southern slopes. The flora of the oak dunes is xerophytic, but of the desert type, while that of the pine dunes is of the arctic xerophytic type. The pine dunes have a northern flora, the oak dunes a southern flora.

VI. Previous studies of sand dune floras.

A great deal of physiographic work has been done in sand dune areas in total disregard of the plant life, although the

results obtained from this study show that the vegetation profoundly modifies the topography. In like manner the flora has often been studied from a purely taxonomic standpoint, little attention being paid to the striking effects of the environment upon plant structures. More recently the ecological standpoint has been taken by a number of investigators, particularly to show the influence of the extreme environment upon plant organs and tissues. The second part of this paper will treat this phase of the subject in some detail. Very little previous work has been done on the geographic phase of the subject from the standpoint of historical development and the order of genetic succession of the various dune types. Still less has there been any adequate study of the modifying influence of vegetation upon topography. These latter phases of the subject have given color to the work which has resulted in this paper.

Warming's work on the sand dune vegetation of Denmark stands in the front rank. In his separate publications and in his text-book of ecology, the conditions on the Danish dunes are quite fully stated. The order of succession, speaking broadly, seems to be quite similar to that along Lake Michigan, but there appears to be less diversity of conditions, and the features appear to be developed on a smaller scale. The strand is succeeded by the wandering or white dunes, and these by the established or gray dunes. Beyond these are sandy fields. Just as along Lake Michigan, the dune floras may pass into the heath and these latter into coniferous forests.

There is a remarkable similarity in the flora of the Danish and Lake Michigan dunes. The same genera and often the same species occur in the two regions. *Cakile maritima* and *Lathyrus maritimus* grow on the strand. *Ammophila arundinacea* (=*Psamma arenaria*), *Elymus arenarius*, and *Agropyrum junceum* grow on the wandering dunes. Where the genera are not common or even nearly related, there are to be found in the two regions plants that have the same life habits. There is thus a striking similarity in the two regions in almost every respect, and that too in spite of the marine conditions in Denmark, as contrasted with

the inland fresh-water area in the United States. The life conditions appear to be essentially alike on all dunes, whether marine or not, and there are found not only identical life habits, but even identical plant species.

Warming reports Chlamydomonas on the strand in the same relations as along Lake Michigan. Among the sand-binding plants, Warming and Graebner give an important place to mosses. Along the Lake Michigan dunes, mosses do not appear to any great extent until establishment is nearly complete. On the Denmark coast, the Agropyrum dunes are lower than those formed by Ammophila, just as along Lake Michigan. The Danish dunes have also been studied by Raunkiaer, Paulsen, and Feilberg. Erikson has studied the similar dunes of southern Sweden, Giltay and Massart those of Holland and Belgium.

The dunes on the islands along the German coast have been carefully studied by Buchenau and to some extent by Knuth. Graebner, in his exhaustive work on the North German heath, discusses the origin of the heath on naked dune sand. He gives an important place to algæ and moss protonema, since they precede other vegetation, forming the first humus and causing the sand grains to cohere. It is doubtful if these lower plants are so important as sand-binders along Lake Michigan. Rothert and Klinge have studied the coast vegetation of Russia.

The French dunes have been very carefully studied by Flahault alone and also in association with Combres. Some work has also been done in France by Constantin and Masclef. Willkomm's work in Spain and Portugal, covering a period of nearly fifty years, is very complete and satisfactory. Daveau has worked out the conditions along the coast of Portugal. On these more southern dunes, the plant species resemble those along Lake Michigan less than do those in northern Europe, but the life habits are the same.

The dune flora of South Africa has been touched upon by Thode, that of Chile by Kurtz and Reiche, that of northern Siberia by Kjellman, that of New Zealand by Diels. The tropical dunes of Indo-Malaysia have been studied in detail by Schimper,

and are fully discussed in his work on the Indo-Malay strand flora and also in his recent Plant Geography. In the latter work there are several excellent discussions of sand dune vegetation, accompanied by photographs from a number of regions. The tropical dunes have totally different species, but even there the dominant dune-formers are grasses with the same life habits as Ammophila.

Dunes may be formed in deserts and inland regions apart from large bodies of water. Those in the Sahara and in the deserts to the northeastward have been more or less studied. Brackebusch has described dunes in Argentina.

In the United States dunes are common along the Atlantic coast, especially in Massachusetts, New Jersey, North Carolina, and Florida. On the Pacific coast they also occur extensively. None of these marine dunes have been exhaustively studied from the ecological standpoint. One of the best works that has ever appeared on strand floras is that by MacMillan on the shores at the Lake of the Woods. The dune formation is not extensive there, but is most admirably treated. As would be expected, there are many species common to Lake Michigan and the Lake of the Woods. The sand hills in the interior have been studied by Rydberg, Hitchcock, and Pound and Clements. Hill has studied the dune floras about Lake Michigan for many years, and although he has not written a great deal along ecological lines, he has had the ecological standpoint thoroughly in mind and the author has received from him a number of valuable suggestions.

THE UNIVERSITY OF CHICAGO.

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BRIEFER ARTICLES.

ORIGIN OF TIMBER BELTS.

In the north central part of Kansas along the Republican river in Clay and Cloud counties, the streams are bordered by narrow interrupted belts of timber. These belts are from a few rods to half a mile in width. The region is near the border line of the great plains, east of the Rocky mountains, where trees are almost entirely absent. Until recently the country was swept annually by devastating prairie fires, and it was only on the sandbars, on the inner side of the river bends where the sedimentary deposits were comparatively free from herbage, that young trees had any chance of surviving. In the region studied, the Republican river passes through the Dakota sandstone, and its bed is very sandy. During overflows the lower portions of the bends are covered by a layer of sand and rich organic detritus, affording an immediate substratum for the vigorous development of young trees, while at the same time the growth of grass and weeds is almost entirely checked because they are partly or completely covered up by the deposits.

The succession of woody plants is as follows: Along the water's edge or at the outer margin of the sandbars, there first grows up a zone of the common long-leaved willow, *Salix longifolia* Muhl. As this advances with the growth of the bar, it is replaced by the black willow, *Salix nigra* Marsh. The black willow finally gives way to a thick growth of cottonwood, *Populus monilifera* Ait. All young timber belts are therefore made up of three zones:

1. A zone of *Salix longifolia* Muhl., generally several rods in width.

2. A strip of *Salix nigra* Marsh, usually a narrower zone than the first.

3. A wide zone of *Populus monilifera* Ait., which makes up the timber belt proper.

I have had some of these young timber belts under observation for nearly twenty years, some from their very beginning, and I find that it is only after the cottonwood has formed a rather thick forest of good-sized trees that other trees common to the region begin to take posses-

sion of the soil. In the limestone region in the southeastern part of Clay county, there are several species of trees which do not pass over into the sandstone district. The trees which finally crowd out the cottonwood are few in number and are of the following species: *Negundo aceroides* Moench, *Gymnocladus Canadensis* Lam., *Gleditschia triacanthos* L., *Cercis Canadensis* L., *Fraxinus viridis* Mx., *Ulmus fulva* Mx., *Ulmus Americana* L., *Celtis occidentalis* L., *Morus rubra* L., and *Juglans nigra* L. Thus, in the older forests, the cottonwood trees stand here and there as solitary giants, crowded on all sides by the newer occupants.

There seems to be good evidence that these timber belts never advanced outward from the river, but rather that fire and prairie grass were continually encroaching upon the forest areas, restricting them to narrow belts along the river, although the river bottoms in some places are several miles in width.—JOHN H. SCHAFFNER, *Columbus, O.*

THE SPREADING OF BUFFALO GRASS.

I HAVE several times read the statement that the buffalo grass, *Buchloe dactyloides* Engelm., is being crowded out and exterminated in regions which have been settled for some time. This does not agree with my own observations, which extend through a period of over twenty years in Clay county, Kansas, a region where this grass is quite common, although it occurs only in small patches here and there in the prairie. Of course, the sum total in a given region would be less at the present time than formerly on account of the great areas now under cultivation. But in the pastures the grass has spread considerably. I know of patches which are at present from six to ten times their original area twenty five years ago when the country was first settled. There are also many places, formerly destitute of buffalo grass, which are now practically covered with it, other species being crowded out.

This increase of the buffalo grass in the pastures is without doubt due to the continual tramping of cattle, which destroys the other common prairie-grasses but does not seem to be injurious — rather beneficial — to the buffalo grass.

I also know of a patch in a yard which has remained a thick sod for twenty five years, while all the other grasses have long since been destroyed and their place taken by weeds and introduced grasses.

In the region under consideration, the buffalo grass usually grows

along the banks of ravines and at the base of hilly slopes where conditions are rather unfavorable. There are a number of characteristic grasses, which go to make up the great bulk of the prairie. The little blue stem or bunch grass, *Andropogon scoparius* Michx., grows mostly on the hills and ridges, while the big blue stem, *Andropogon furcatus* Muhl., occupies the more level and richer areas. Along with the big blue stem the Indian grass, *Chrysopogon nutans* (L.) Benth., and the switch grass, *Panicum virgatum* L., occur in considerable abundance, while in very wet ravines it is largely displaced by the slough grass *Spartina cynosuroides* Willd.—JOHN H. SCHAFFNER, *Columbus. O.*

A WASHING APPARATUS.

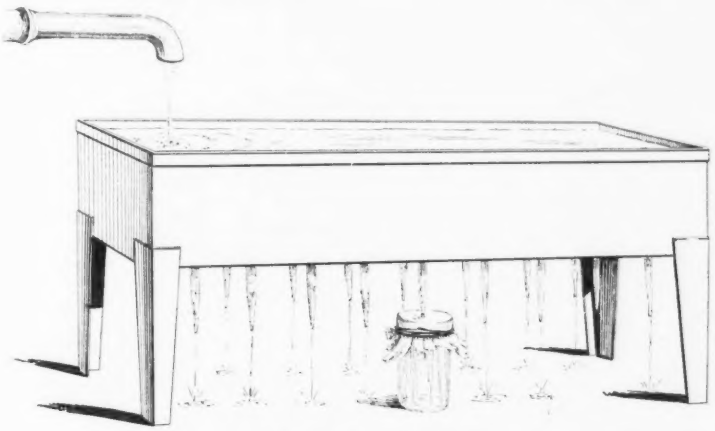
(WITH FIGURE.)

FOR some time we have felt the need in our laboratory of an apparatus adapted to washing material fixed in certain solutions, such as chromic acid and Flemming's chromo-aceto-osmic mixture. Such a device should be at once simple in structure, capable of accommodating several bottles of material at once, and should provide a current of water strong enough to insure a constant and gentle agitation of the material, and at the same time one not so violent as to injure the most delicate tissues.

Such an apparatus has been made for our own laboratory, and after a year of use it fills all the requirements so perfectly that it has been thought desirable to publish a description of it in the hope that others might profit by our experience. It consists, essentially, of a trough supported on legs, and provided with a cork bottom, through holes in which are passed glass tubes drawn out to a point at the lower end. When the material is ready for washing, a fine meshed cloth is stretched over the mouth of the bottle, and held in place by a rubber band. The bottle is then placed beneath the trough, and one of the tubes is lowered until the pointed end projects through the cloth into the bottle. If water be then allowed to run into the trough until it is nearly full, the head of water will be sufficient to cause it to flow through the glass tube into the bottle with just enough force to produce a gentle agitation or circulation of the material. The water passes off through the meshes of the cloth.

The trough may, of course, be made of any material, of any size,

and high enough to accommodate any bottle. The one here described is of tin, 6.25^{cm} deep, and of a size to fit the ordinary sheet of insect cork, 8.75^{cm} × 29.5^{cm}. The space beneath the trough is 7.5^{cm} high. The cork bottom should be at least 1^{cm} thick to be sufficiently stiff. The holes are 1.8^{cm} from the edge, and are 3.75^{cm} apart. This gives room for eighteen 25^{mm} bottles of material to be washed at one time



A WASHING APPARATUS.

without crowding. The cork is supported by having the sides and ends of the trough turned in 5^{mm} at the bottom. In addition to this, the bottom should be held by at least four narrow metal cross pieces, both above and below, to prevent the cork from warping when wet. The glass tubes are 6.75^{cm} long, with an inside diameter of 3^{mm}. They should fit just tightly enough in the holes to allow of being slipped up and down. The trough is kept in a sink under one faucet, and only a small stream is needed to keep it running. One needs only to see the apparatus at work to be convinced of its completeness.— ELIAS J. DURAND, *Botanical Laboratory, Cornell University*.

PHACELIA COVILLEI AT MT. CARMEL, ILL.

ON May 5, 1889, Mr. F. V. Coville found a Phacelia on Larkspur island, on the Potomac, about five miles above Washington, D. C.[1]

[1] BOT. GAZ. **21**: 233. 1896.

This was sent to Dr. Sereno Watson, who regarded it as a new species, and published it under the name of *Phacelia Covillei* in the sixth edition of Gray's manual. It was not found again on the Potomac until April 1895, when it was taken at several points on the Potomac river opposite its original station.

On May 8, 1888, in company with Dr. W. Trelease, I found this plant growing in low, rich, bottom lands along the border of a cypress swamp, in Knox county, Ind., two miles east of Mt. Carmel, Ill. I had found it before, in several localities, near Mt. Carmel, and always in low lands that are subject to overflow during times of high water, but had regarded it as *Macrocalyx Nyctelea* (L.) Kuntze (*Ellisia Nyctelea* L.), until I finally found the real Macrocalyx. I was then unable to locate the first plant until after I had received the sixth edition of Gray's Manual, by means of which I found it to be *Phacelia Covellei* Watson. This diagnosis has been confirmed by Dr. N. L. Britton and others. Its general appearance is much like that of *Macrocalyx Nyctelea*, while the large globose, one-celled capsule places it with the Phacelias. These peculiarities have led some of the botanists at Washington to suspect it as being a hybrid between *Phacelia dubia* and *Macrocalyx Nyctelea*; but as the former species is not found in the vicinity of Mt. Carmel this can hardly be true.

Mt. Carmel, Ill., and Washington, D. C., are nearly in the same latitude, and a comparison of the published local floras[2] of these two localities shows that they have many species in common. The flora at Washington receives intrusions from the maritime and Alleghanian regions, while the flora at Mt. Carmel has been modified by many additions of southern and western immigrants, so that it is not surprising to find this riparian plant growing on the banks of the Wabash as well as on those of the Potomac. It is reasonable to suppose that it occurs at intermediate stations, and perhaps to the westward, but that it has been considered to be the Macrocalyx and has been so labeled when collected.—J. SCHNECK, *Mt. Carmel, Ill.*

[2] WARD, Bull. U. S. Nat. Mus. **22**: 104. 1881; Schneck, Geolog. Surv. Ind. 1875: 504.

EDITORIAL.

Science, falsely so called

THE leading article in the *Popular Science Monthly* for February bears the sonorous title, "Vegetation a remedy for the summer heat of cities. A plea for the cultivation of trees, shrubs, plants, vines, and grasses in the streets of New York, for the improvement of the public health, for the comfort of summer residents, and for ornamentation." With tree planting in cities the BOTANICAL GAZETTE is in warmest sympathy, but the arguments advanced by Stephen Smith, M.D., LL.D., "to revive the project of giving the Department of Parks jurisdiction over the trees in the streets, and require it to plant and cultivate additional . . . . vegetation" are calculated to astonish the botanist, and make him grieve over the popular inculcation of such ridiculous physiology. "The real problem to be solved may be thus stated. How can the temperature of the city of New York be modified during the summer months?" According to the writer trees can do this, because "forests and even single trees . . . . tend to equalize temperature, preventing extremes both in summer and winter." This they do "through their own inherent warmth, which always remains at a fixed standard both in summer and winter." Then, since "the vaporization of liquids is a frigorific process," and plants "emit into the atmosphere considerable quantities of water vapor," it is evident that "vegetation tends powerfully to cool the atmosphere during a summer day." Since "man may live in close proximity to marshes from which arises the most dangerous malaria with the utmost impunity [bold, bad malaria!], provided a grove intervene between his home and the marsh," it is fortunate that "at the period of the day when malaria and mephitic gases are emitted in the greatest quantity and activity, this function of vegetation is most active and powerful."

It is greatly to be regretted that such utterly erroneous conceptions of the work of plants, of which the above are only samples, should find publication at all, and much more that they should appear in a journal which speaks in the name of science, as the *Popular Science Monthly* claims to do. Or must "popular science" be considered merely a pseudonym for grotesque or sentimental fol-de-rol?

OPEN LETTERS.

A READY SUPPLY OF VAUCHERIA.

TEACHERS of botany are often put to much trouble in securing good fruiting material of the stock algæ at times of the year when material cannot be obtained out of doors. A good supply of Vaucheria can be obtained at any time with very little trouble. Five or six weeks before the material is needed some Vaucheria should be obtained in any greenhouse from the surface of the soil of potted plants, and brought to the laboratory without disturbing the mats. After removing as much of the soil as possible the mats should be thrown into a jar half full of water and put where the sun may shine upon them. In the experiments made it was found that after a week considerable change in the color of the filaments had occurred, and after five or six weeks the material was found in excellent condition, showing both methods of reproduction, zoospores in all stages of germination, and the vegetative body also thriving better than if grown on soil. In this way a supply free from other algæ and from sand, and in amounts sufficient to supply classes of over two hundred students, was obtained at short notice. The species experimented with was *Vaucheria sessilis*.— BRUNO A. GOLDBERGER, *Chicago*.

STAINING TECHNIQUE.

BASIC fuchsin (1 per cent. aqueous solution) can be very satisfactorily substituted for safranin in the Flemming triple stain, and at least in many cases gives a more brilliant red. The same elements seem to take the fuchsin as take the safranin. The stain goes through the same manipulations, clearing, etc., as are used with the Flemming combination, without visible alteration. Slides are best left in the fuchsin over night and excess extracted with 35 per cent. alcohol. This extraction is slow enough to be easily controlled. —H. F. ROBERTS, *The University of Chicago*.

CURRENT LITERATURE.

BOOK REVIEWS.

The nutrition of plants.

THIS central subject of plant physiology, as to which there is so great an amount of popular misapprehension, is the one most directly important to all growers of plants. The Germans are fortunate in having had for some years a clear and interesting little book on this subject, of which the second edition has recently been issued.[1] Dr. Adolph Hansen, the author, prepared the original book more for his own satisfaction, he says, than with any ulterior purpose; but it found so wide a circle of readers that both author and publisher seem under necessity to provide a new edition.

The book treats of the source of carbon, the organs by which CO_2 is absorbed and elaborated, the significance of light for photosynthesis (this term is used throughout), and the product. The author then considers the nitrogen supply, the mineral constituents, the organs (roots) by which they are chiefly obtained, and the movements of water, including its loss and the regulation thereof. As "nutrition" is used in its widest sense, he further discusses the production of proteid, the translocation of plastic substances, and respiration. The non-green plants, both spermatophytes and fungi, receive scant treatment in a concluding chapter.

The book is admirably written in clear and simple language, and the facts are handled in an attractive way. Theoretical considerations are not excluded, and even these are lucidly presented. There is little to criticise unfavorably. Only one fundamental definition we must dissent from — a definition which the author should reconsider—"Foods of the plant are those substances without which the plant could not exist."

We should be glad to see such a book in English. It would be immensely useful to plant growers and for popular reading.—C. R. B.

The completed host index.

THE thirteenth volume of Saccardo's *Sylloge fungorum*, a notice of the first half of which was given in a previous issue of this journal,[2] is now complete, having been issued in parts. It has been prepared by Dr. P.

[1] HANSEN, ADOLPH: Die Ernährung der Pflanzen. 12mo. pp. iv + 299. *figs.* 79. Wien: F. Tempsky; Leipzig: G. Freytag. 1898. *M* 5.

[2] BOT. GAZ. **25**: 287.

Sydow,[3] with some assistance from P. A. Saccardo, G. Lindau, and P. Hennings, to whom acknowledgment is made in the preface. The work is brought down to the end of the year 1897.

The type is good, and the spacing ample, so that the volume can be consulted with readiness and comfort. The host species are arranged in a single alphabet, following the authority of the *Index Kewensis*, with the fungi associated with each species named immediately beneath.

The attempt has been made to use but one name for each species of host and of fungus, thus omitting synonyms. The imperfections in the literature of the fungi have made it especially difficult to follow out the plan with the desired success. It is easy to point out names that should have been omitted, as they are clearly synonyms, and to mention others that should have been included. But such shortcomings are incident to the subject, and only emphasize the necessity for early monographic work.

To anyone determining parasitic fungi the volume will prove of the greatest service, and, in connection with the descriptive part of the great *Sylloge*, will be especially welcome.— J. C. A.

What is "vital energy?"

THE PROBLEM before the physiologist is the nature of living matter. Anything that contributes to a solution of this problem is welcome. Dr. Oscar Loew has already done much to make possible a better understanding of the chemistry of protoplasm and its products. In a work published in London in 1896 entitled *The energy of living protoplasm*, he set forth in English the views which now find a more complete exposition in German under the title, *The chemical energy of living cells*.[4] As the former work was not received by the GAZETTE for review, a somewhat extended résumé of his views may now be useful.

After giving a historical summary of previous views as to the causes of vital activity, he avers that the *primum movens* of the living cell is to be sought neither in heat nor electricity, but in a specific chemical activity, viz., the assumption of oxygen by the living substance. The main question, then is, "What conditions lead to the activity of cell respiration and to the transformation of the heat thereby produced into the chemical energy of the living cells?"

The living protoplasm, "at once artificer, work-shop, and plastic material,"

[3] SYDOW, P.— Sylloge fungorum omnium hucusque cognitorum digessit P. A. Saccardo, Vol. XIII; Index universalis et locupletissimus nominum plantarum hospitum specierumque omnium fungorum has incolentium quæ usque ad finem anni 1897 innotuerunt. Roy. 8vo, pp. vi + 1340. Berolini: Fratres Borntraeger, 1898.

[4] LOEW, OSCAR: Die chemische Energie der lebenden Zellen. 8vo. pp. xii+ 175. München: Dr. E. Wolff. 1899. *M* 5; geb. *M* 6.

as Hanstein well says, is declared by Loew to be no variable mixture of proteids (as Reinke, Verworn, Pfeffer, and others hold), but organized proteid, whose vital energy depends on its chemical character, as its vital functions depend on its organization. Dead protoplasm and living protoplasm are chemically different; the former is chemically stable while the latter is chemically active or labile, *i. e.*, possessing much kinetic chemical energy, it enters into reaction very readily. Death is the transformation from the labile to the stable form of proteid, by the displacement of certain atoms in the molecule. A labile proteid sometimes occurs as a reserve substance in plants. This is the material whose reaction with silver salts in weak ammoniacal solution was discovered by Loew and Bokorny and was thought to be the reaction of living protoplasm.

With the proteid are combined certain salts of sodium, calcium, magnesium, and iron oxid, and phosphoric acid. The rôle of these materials is discussed, and their importance in the chemical processes pointed out.

After enumerating the biochemical work, and discussing the nature of catalytic processes at some length, two chapters are devoted to the formation of proteids in fungi and in green plants. In another are explained clearly the author's well-known views that labile proteids arise in the higher plants from formaldehyde and ammonia, by way of the aldehyde of asparaginic acid. Thus:

$$\underset{\text{Formaldehyde}}{4\,CH_2O} + \underset{\text{Ammonia}}{NH_3} = \left.\begin{matrix} CHO \\ CH.NH_2 \\ CH_2 \\ CHO \end{matrix}\right\} + H_2O \quad \text{Aldehyde of asparaginic acid}$$

$$\underset{\text{Aldehyde of asparaginic acid}}{3\,C_4H_7NO_3} = \underset{\text{An intermediate product}}{C_{12}H_{17}N_3O_4} + 2\,H_2O$$

$$\underset{\text{Intermediate product}}{6\,C_{12}H_{17}N_3O_4} + 12H + H_2S = \underset{\text{Lieberkühn's proteid formula}}{C_{72}H_{112}N_{18}SO_{22}} + 21H_2O$$

Of course, in the absence of any definite knowledge of the molecular weight of proteid or its exact composition, it is evident that these details can only be theoretical; nevertheless the theory may prove highly useful.

The ninth and tenth chapters (written in collaboration with Th. Borkorny) discuss the labile proteid which they found as a reserve material, its chemical characteristics, and its relation to living proteid.

In the eleventh chapter the author seeks to show upon what the lability (and consequent activity) of the protoplasm depends. It is probably due, he says, to the simultaneous presence in the molecule of aldehyde (CHO) and amido (NH_2) groups; that is, the proteids of living protoplasm are amido-aldehydes, which at death lose their aldehyde groups wholly and the amido groups in large part. Recalling the dictum of Sachs, "The dead organism is dead simply because it has lost its irritability," one may well couple with it the dictum of Loew, "No irritability without lability."

The concluding chapters are devoted to the presentation of a theory

of respiration which may be called the catalytic theory. Loew holds that contact with the living proteid, whose intense kinetic energy is predicated, so increases the lability of the CHOH groups in sugars and of the CH_2 groups in the fatty and amido acids that combination with free oxygen follows, to such an extent that these substances are totally oxidized. In the course of this oxidation, the O_2 is split up into its atoms, but not before. By the energy thus set free as heat, appropriate substances may be raised to the labile condition, and other work done. The protoplasm, in rendering the foods labile, suffers a loss of energy, but this loss is again covered by the energy set free in the oxidation. If free O is wanting, the sugar breaks up into other products (fats, lactic acid, etc.), constituting intramolecular respiration. Loew combats vigorously the accepted idea of a continuous dissociation and regeneration of living substance, holding that the impairment involved would be more likely to result in death than in life. For, if the amount of thermogenous foods in a cell becomes considerably diminished, the lability of the plasma proteid leads to its own direct assumption of oxygen; and when only a small part of the proteid has been altered by oxidation, disorganization follows; that is, death by hunger.

The theory of vital energy thus set forth is a consistent one, and is supported by many strong arguments from the chemical side. It is, of course, diametrically opposed to the view which Pflüger and many other physiologists hold, that lability of protoplasm is due to the presence of cyanogen groups (CN), and that respiration is the oxidation of protoplasm itself, at which climax of chemical power it decomposes continuously, to be as continuously rebuilt out of available foods.

There are difficulties in both theories, and physiologists will do well to read and ponder this clear and interesting book by Dr. Loew.—C. R. B.

NOTES FOR STUDENTS.

M. EDMOND GAIN has endeavored to determine whether the material known as *alinite*, which is recommended for increasing the fertility of the soil through the activity of bacteria, was efficient for this purpose. The active microbe of this product is *Bacillus Ellenbachensis* α (*B. Megatherium* DeBary). His experiments, though not numerous enough to determine the question satisfactorily, indicate that "the addition of alinite produces a beneficial effect, which manifests itself in greater vegetative development of the plants [buckwheat and flax], and in a larger crop of seeds."[5]—C. R. B.

PURIEWITSCH has determined that the splitting of most glucosides by fungi is accomplished extracellularly, through the splitting action of emulsin, into glucose and benzene derivatives.[6] This action is carried on both by

[5] Revue gén. de Botanique **11**: 18–28. 1899.

Berichte der deutsch. bot Gesells. **16**: 368. 1898.

germinating spores and by developed mycelium. The glucose produced is first completely used by the plant; the benzene derivatives are then used very much more slowly, if at all. Amygdalin, as attacked by most fungi, forms an exception to the foregoing statement. Though it may be split by emulsin into glucose, benzaldehyde, and hydrocyanic acid, it is usually broken up by invertin into glucose and amygdalic acid, the latter being further decomposed into glucose and mandelic acid.—C. R. B.

SINCE Strasburger's thorough work on *Polygonum divaricatum* (1879) little or nothing has been done with the embryology of any nearly related plant. A recent article on Rumex[7] shows that in this genus the origin and development of the megaspore is the same as in Polygonum, viz: an archesporial cell divides into a primary tapetal cell and a sporogenous cell, the latter giving rise to four megaspores, one of which germinates. The small size of the nuclei makes this rather unfavorable for cytological study, but, judging from the plates, the very clearly defined sequence preceding the formation of the endosperm nucleus (secondary nucleus) indicates that Nawaschin's recent theory could be shown to be inapplicable in this case.—C. J. CHAMBERLAIN.

DR. HANS MOLISCH presented to the Imperial Academy of Sciences in Vienna at the meeting on December 1, 1898, a paper upon "The Secretion of Palm Wine and its Causes." Heretofore the bleeding of the palm when the inflorescence was amputated has been ascribed to root pressure. Three circumstances awaken doubt of this: (1) Were root pressure the cause, it should be observable at the base of the stem; (2) bleeding occurs in the very tall palms, at heights (19–28^{m}) which it is doubtful if root pressure could reach; and (3) bleeding takes place during full leafage.

Researches showed that in Cocos and Arenga root pressure was scarcely to be detected at the base of the stem, and from borings at this point no sap escaped, though it poured out abundantly above. Moreover, a spadix, completely severed, continued to bleed for one or two days and developed a not insignificant bleeding pressure. The osmotic pressure, therefore, according to Molisch, has its origin not in the root but in the axis of inflorescence of Cocos and in the adjacent upper part of the stem in Arenga.[8]—C. R. B.

HERR LIND introduces an article on the penetration of fungi into limestone and bones[9] with a twelve-page summary of the previous work on the

[7] FINK BRUCE: Contribution to the life history of Rumex. Minnesota Bot. Studies. **2**: 137–153. *pl. 9–12.* 1899.

[8] Cf. Oesterr. bot. Zeits. **49**: 74. 1899.

[9] LIND, K.: Ueber das eindringen von Pilzen in Kalkstein und Knochen. Jahrb. f. wiss. Bot. **32**: 603–634. 1898.

subject, from which it is evident that the greatest knowledge has come through dental studies. It has long been known that fungi, algæ, and lichens can corrode or bore into rock, bone, or shell, and it has been assumed that they did this by excreting at the growing tip an acid which dissolved the calcareous material that it touched. Miyoshi in 1895 proved that chemotactic irritation induced the penetration of a cellulose membrane by fungi. Experimental proof of the cause and manner of penetration of calcareous objects seems to appear first in Lind's work. By adopting careful antiseptic precautions, he proves that a fungus may penetrate marble, chalk, eggshell, or bone plates, 0.07 to 0.2^{mm} in thickness, in eight or ten days. To do this there must be a chemotactic stimulus, usually furnished by some organic or inorganic food material that is needed by the plant. The stimulus seems useful to cause the acid-forming surface to be pressed close to the rock in order to secure a sharply localized action. Microscopic examination shows that the fungus may pass directly through crystals. From a study of the action of oxalic and carbonic acids, the author concludes that the latter is primarily responsible for the etching, though oxalic acid may be accessory, especially in the presence of sodium chlorid which may afford hydrochloric acid by combination. The greater prevalence of such perforations in marine than in fresh water shells is thereby explained.— F. L. STEVENS.

ITEMS OF TAXONOMIC INTEREST are as follows: In *Bulletin of the Torrey Botanical Club* **26**: 63–71. 1899) CHARLES H. PECK has described twenty new species of fleshy fungi.— ELIZABETH G. BRITTON (*ibid.* 79–81) has described a new Tertiary moss (Rhynchostegium) which is probably the oldest species yet found in this country.— ANNA MURRAY VAIL (*ibid.* 106–107) continues her studies of the Leguminosæ, presenting the genus Dolicholus (Rhynchosia), with sixteen species.— CHARLES MOHR (*ibid.* 118–121) has described new species of Prunus, Physalis, and Solidago from Alabama.— AVEN NELSON (*ibid.* 122–134) continues his description of new species from Wyoming, the present fascicle containing seventeen species in widely scattered genera. — K. M. WIEGAND (*ibid.* 135–137) has described some new species from Washington, and also (157–171) has published a revision of Listera, including twelve species, seven of them North American, two of which are new.— In *Pittonia* (**4**: 25–52. 1899) E. L. GREENE publishes twenty seven new species in miscellaneous genera, the largest number being added to Sisyrinchium (5) and Silphium (4); discusses chronologically early specific types in Chamæcrista as distinct from Cassia, discovers some twenty-three, and transfers them from Cassia to Chamæcrista; brings up certain neglected generic types, recognizes *Phyla* Loureiro for *Lippia* Mx., separates *Sieversia* Willd. from *Geum*, and establishes *Vancleavea* Greene upon *Grindelia stylosa* Eastwood.— Circulars 9 and 10 of the Division of Agrostology contain contributions by LAMSON-SCRIBNER and WILLIAMS, thirteen

new species and several new varieties of Poa being described, as well as species in Eragrostis and Elymus.— A continuation of Schinz's (Zürich) work on the African flora appears in *Bull. Herb. Boiss.* (7: 24–65. 1899), the separate being published as *Contrib. Bot. Mus. Univ. Zürich.* The most important papers are as follows: Gramineæ (7 n. spp.), by E. HACKEL; Leguminosæ (12 n. spp. and a new genus *Neorautanenia*), by HANS SCHINZ; and the fourth installment of Convolvulaceæ, by H. HALLIER.—J. M. C.

THE QUESTION of the sexuality of Collema is discussed by Baur[10] who adds some interesting observations to our imperfect knowledge of the peculiar conditions preceding the ascocarp in this form. He confirms Stahl's original observation and gives us a more detailed account of the cytology of the archicarp and trichogyne than has yet been presented. It seems that the cells of the spirally twisted archicarp and the trichogyne which rises from it are in communication with one another by delicate strands of protoplasm that run through a pore in the center of each cross-wall. The entire structure consists of 25–40 cells, 15–20 constituting the archicarp and the remainder making up the multicellular trichogyne. Each cell contains a single nucleus, that in the terminal cell of the trichogyne being slightly larger than the others. Spermatia were observed fused with the projecting tips of the trichogyne.

A medium sized thallus of Collema will produce every season, spring and autumn, many hundreds of archicarps with their trichogynes, but of these less than one per cent mature fruit. The others gradually wither from above downwards, and the basal portions become a part of the vegetative mycelium of the lichen. No spermatia were ever observed attached to withering trichogynes. Sometimes lichen thalli will bear thousands of archicarps, and yet produce no apothecia. Baur believes he has found the explanation in the absence of spermogonia on such specimens. An apothecium lives for several years and the first asci are formed from six to twelve months after fertilization.

Baur's conclusions on the mechanism of fertilization are not final, his paper being in the nature of a preliminary contribution. From observations on several specimens he believes that, as the result of fertilization, the nuclei of the trichogyne gradually become disorganized, beginning from above, until only the cells of the archicarp remain unchanged. Finally all the cells above the archicarp break down. Baur points out two ways in which fertilization might be accomplished. Perhaps the sperm nucleus passes down through the disorganized cells of the trichogyne and fertilizes one or more cells of the archicarp; or it is possible that the sexual act may take place in the terminal cell of the trichogyne, and that a fusion nucleus makes

[10] BAUR: Zur Frage nach der Sexualität der Collemaceen. Ber. d. deut. bot. Gesells. **16**: 363. 1898.

its way into the archicarp, giving rise by its activity to the system of hyphæ that constitutes the ascocarp. The last explanation is apparently suggested by Oltmanns' recent work on the Rhodophyceæ.—B. M. DAVIS.

BULLETINS of the experiment stations not heretofore mentioned relating to plant diseases are as follows: "Diseases of plants," by A. P. Anderson S. C., no. 36, pp. 1–17, illust.), gives a brief popular account of the rôle of fungi and bacteria as disease agents. The same author writes upon "The asparagus rust in South Carolina" (S. C., no. 38, pp. 1–10, illust.), while Byron D. Halsted gives more extended observations upon "The asparagus rust, its treatment and natural enemies" (N. J., no. 129, pp. 1–20, illust.). In a "Preliminary report upon diseases of the peach; experiments in spraying peach trees," Aug. D. Selby (Ohio, no. 92, pp. 179–268, illust.) gives a large amount of information with much original observation, to which a serviceable index is added. The same investigator also writes upon "Some diseases of wheat and oats" (Ohio, no. 97, pp. 31–61, illust.) especially of smuts, rust, scab and glume spot. The Fusarium causing scab of wheat is said to be *F. roseum* Lk. The ascigerous stage was found and almost certainly identified as *Gibberella Saubinetii* (Mont.) Sacc. Cultures were made, but attempted infection of living plants was not successful. In an account of "Pea canning in Delaware" by G. Harold Powell (Del., no. 41, pp. 1–16, illust.) is a description (pp. 8–11) of sun scald of peas caused by *Ascochyta Pisi*. A comprehensive treatment of the "Diseases of the tomato" by P. H. Rolfs (Fla., no. 47, pp. 117–153, illust.) recounts practical observations upon the cause and prevention of eleven diseases. Black rot (Macrosporium) is the most prevalent, and can be prevented by spraying with Bordeaux mixture; a bacterial disease is common and less easily controlled; and what is locally known as "white mold," although due not to a fungus but to *Phytoptus Calcladophora* Nal., is not yet reported from any other state. The bulletin is well written and printed, and is a model for a practical treatise. Observations on "Cotton rust" are given by F. S. Earle (Ala., no. 99, pp. 281–309) in addition to previous accounts by Dr. Atkinson. B. M. Duggar (Cornell, no. 163, pp. 339–363, illust.) has studied "Three important fungous diseases of the sugar beet," which are root rot (*Rhizoctonia* ~~Beta~~ *Betae* Kühn), leaf spot (*Cercospora beticola* Sacc.) and scab (*Oospora scabies* Thax.). Much original information is given regarding the fungi, the diseases they cause, and remedies, followed by a bibliography. The same author presents important notes on "Peach leaf curl and notes on the shot-hole effect of peaches and plums" (Cornell, no. 164, pp. 371–388, illust.), emphasizing the value of early spraying with Bordeaux mixture for the former, and showing that the latter is often produced by spraying and other non-fungous causes. A concise account, with observations within the state of Vermont, is given by L. R. Jones (Vt., no. 66, pp. 1–16, illust.) of "Club root and black rot,

two diseases of the cabbage and turnip," the former mycetozoan and the latter bacterial, both widely distributed and common. "Suggestions as to spraying" by J. A. Tillinghast and G. E. Adams (R. I., no. 52, pp. 1–48, illust.) is a convenient and well prepared handbook of plant diseases amenable to spraying, with directions for the work. It is a more valuable bulletin than the title indicates. An extended report on "Spraying cucumbers in the season of 1898," by F. A. Sirrine and F. C. Stewart (N. Y., no. 156, pp. 375–396, illust.) shows the value of frequent use of Bordeaux mixture during the latter part of the season against *Plasmopara Cubensis*. The advantages and methods in the use of "Formalin for grain and potatoes," especially for smut of oats and wheat and scab of potatoes, are presented by J. C. Arthur (Ind., no. 77, pp. 38–44). The chemical composition of "Some spraying mixtures" has been determined by George W. Cavanaugh (Cornell, no. 149, pp. 719–721). Spraying calendars are issued by the Michigan (Special no. 12) and Ohio (no. 102) stations, the latter being especially complete and convenient.

Copies of the above bulletins may usually be obtained without expense by sending a request to the *Director of the Station*, addressed respectively in the order given above: Clemson College, S. C.; New Brunswick, N. J.; Wooster, Ohio; Newark, Del.; Lake City, Fla.; Auburn, Ala.; Cornell Univ., Ithaca, N. Y.; Burlington, Vt.; Kingston, R. I.; Geneva, N. Y.; Lafayette, Ind.; and Agricultural College, Mich.—J. C. A.

A RECENT paper by Nordhausen on parasitic fungi[11] is of great value. It starts with the scientific conclusions of Miyoshi regarding the penetration of membranes by fungi and extends the work, laying an accurate foundation for the knowledge of the conditions of natural infection of plants by invading fungi. The paper deals with such questions as the method of infection; the influence of the condition of the host upon resistance to infection; the cause of epidemics, etc. Nordhausen experiments with hemisaprophytes, and proves that sporelings, growing in a drop of pure water on the epidermis cannot gain entrance to the plant without nourishment additional to that contained in the spores. However, when injected hypodermically in vessels or pith cavities, they grow and cause death throughout the structure. So it seems that a spore can infect living cells without the intervention of a period of saprophytic existence if unprotected or poorly protected cells are available. It is the epidermis that protects the tissue from invasion. Flower leaves do not have a resistant epidermis, and some most valuable observations were made regarding the effects of spores germinating on petals. A yellow spot marked the position of the spore, and the protoplasm of the adjoining cells was brown even eight hours after the spore had arrived and *before its germ*

[11] NORDHAUSEN, M.: Beiträge zur Biologie parasitarer Pilze. Jahrb. f. wiss. Bot. 33: 1–46. 1899.

tube had entered. This must have been due to a toxin freed during the germination. The author investigated this further and proved that it was a very vigorous substance. The browning of the cell walls precedes death of the protoplasm. The author concludes, from what seems to be ample evidence, that there are two substances produced, an enzyme that browns the wall and digests it, thus producing a soluble substance which attracts the germ tube chemotropically. Later there is a toxin which kills the cell and this affords the fungus a base of supplies for a saprophytic existence. Thereafter it may easily invade surrounding tissues to any extent. Slight humidity favors germination of the spore, but great dampness dilutes the toxin and enzyme; therefore the optimum destruction is at a moderate humidity. The author holds that, even in the case of subepidermal wounds or the hypodermic injection of sugar (Miyoshi), the fungus does not attack live cells, but its saprophytic existence is thus assured while it liberates its toxin; it is also possibly aided by weakening of the resistance of the cell through the unnatural conditions. Many suggestions are made regarding the influence of the condition of the host upon resistance; among them, that normal structure counts for much (*e. g.*, thick epidermis); growing portions are susceptible because thin walled; similarly, great dryness weakens the resistance of the ectoplasm, and lack of light results in a thin wall, etc. The author attributes epidemics largely to climatic conditions, or to a breeding place for the fungus where it may obtain food for its existence as a saprophyte. He explains that in such times any particular host species succumbs probably because it furnishes a foothold in some way for a temporary saprophytic existence of the parasite. Or, a given plant may through its own specific heat cause an exactly favorable amount of dew to be condensed on its surface.

Two more questions are investigated, viz.: Can a representative pure saprophyte (*e. g.*, Penicillium, Mucor) under certain conditions become a parasite? Why are they so seldom parasitic? The first is answered abundantly in the affirmative (*e. g.*, fruit decay). Why they are not often parasites is shown by the fact that they cannot penetrate a live cell, even of the mesophyll, although they can penetrate cell walls and may live among them. Host cells may even live for sometime in contact with the mycelium. It seems, therefore, that these fungi make no toxin, as do the parasites or hemisaprophytes. In the case of wounds the reaction of the plant is important. The host may set to forming parenchyma; then the advance of the fungus will depend upon how much it can hinder this recuperative process. It is fight to the death between the host and the fungus. Botrytis is usually victorious, but not always, as victory is to a certain extent dependent upon the amount of resistance of the host. In the case of saprophytes the host's resistance is more important, as the fight is waged in every cell anew, but to even such fungi, fruits are so slightly resistant as to be an easy prey. It is

to be hoped that the author will extend his work to the consideration of the behavior of parasitic fungi.— F. L. STEVENS.

THE ELABORATE MONOGRAPH on starch published a few years ago by Meyer is now followed by a comprehensive account of the state of knowledge regarding inulin and carbohydrates of somewhat similar nature which occur in many plants.[12] Dr. Hugo Fischer gives in the first half of this paper an account of the chemical nature of inulin. Like most of the polysaccharides the composition of its molecule is not known. It is built up of fructose units, but the number of molecules of fructose in each molecule of inulin is not known, and the suggestions vary within wide limits. The low osmotic pressure of solutions of inulin indicate that the molecule is very large. Several modifications of inulin have been described, but the independent existence of these as chemical individuals is not demonstrated. It is possible that some of them (perhaps all) are decomposition products of inulin.

Fischer describes the formation of the spheroidal masses of inulin in plant tissues and compares with these the other spheritic structures occurring in plants, particularly hesperidin (a glucoside occurring in Citrus rind) and calcium phosphate or malophosphate. The latter includes a nucleus of non-crystalline material (perhaps containing proteid). In its spheritic form inulin resembles starch grains in many ways, particularly in swelling upon the imbibition of water at ordinary temperatures and in double refraction. Inulin, however, does not swell like starch, on the application of hot water, alkalies, etc., but dissolves like soluble crystals or breaks up into granules which dissolve.

In the last part of his paper Fischer describes the occurrence of inulin, gives a list of the plants in which it has been found (about 140 species, including 95 Compositæ, about 25 species of allied families, a half dozen Violaceæ, two monocotyledons, and a few algæ), and discusses the methods and places of manufacture, transportation, and storage.

The most important theoretical part of this monograph is the discussion of the structure of inulin masses and starch grains, particularly in view of the trichite theory of the structure of starch grains proposed by Meyer. Meyer held that the swelling of starch was *due* to the spheritic structure, ignoring the facts that many spherites do not swell and that many bodies which do swell are non-spheritic. Fischer shows that when starch grains are air dry (still, however, containing 20 per cent. of water), this water is not free, since it does not indicate its presence by a test with cobalt chloride. Both inulin and starch absorb certain solutions of coloring matters. Did these solutions enter into the spaces between the crystals, as Meyer holds, all should be alike absorbed. But some coloring substances do not penetrate. To explain this it would be necessary to assume that their molecules were large enough to

[12] COHN's Beiträge zur Biologie der Pflanzen **8**: 53–10. 1899.

approach the limit of visibility, since the trichites are, according to Meyer, so slender as to approach this limit. This is, of course, an absurd assumption. Fischer shows also that the storing of colors is difficult or impossible to explain on the crystal-trichite theory. It is well known, however, that colloids and even liquids (*e. g.*, clove oil) are able to store up coloring matter, but no crystals are known which do this. Moreover, starch and inulin which have been stained while wet and then air-dried cannot be decolorized by alcohol or clove oil. It is impossible to understand why alcohol cannot penetrate between the trichites and withdraw the coloring matter, since, even, in the air-dry condition, there is still 20 per cent. of water around the trichites. The relations of starch to iodine, also, are difficult to explain on Meyer's theory. Only when wet does starch give the well-known blue reaction with iodine; dry grains react brown. When blue grains are air-dried they become brown. To explain this upon the crystal theory would require us to assume that when the trichites are surrounded by a little water the iodine solution is brown, but when the crystals are surrounded by a larger quantity of water it is blue; again, an impossible assumption.

Fischer also criticises Bütschli's theory of "foam" structure for bodies capable of swelling, in which an attempt is made to explain the force developed by imbibition by osmotic action of the substance occupying the "bubble" spaces. His own view, stated very briefly, is that both in starch and inulin a true chemical relation exists between water and the molecules of amylose and inulin, in consequence of which the molecular structure is different according as greater or less quantities of water are present, after the analogy of some crystals. Watery amylose and inulin have different physical properties from those they possess when air-dry. Only in the watery condition can they dissolve in their own substance and store certain coloring matters; others are insoluble. Iodine, whose tints differ according to the solvent, is dissolved in watery amylose with a blue tint. When air-dry the iodine is not in solution, but is distributed through the amylose in fine solid particles.

Swelling, Fischer holds, is thus a purely molecular process — a loose combination of molecules with water after the fashion of water of crystallization in some salts. Upon an increase of water this condition passes without break into the state known as solution, that is, a still looser relation of the molecules to water. The fact that imbibition occurs for inulin, starch, cellulose, gums, gelatin, etc. only with water, supports this view. The radial structure of both starch and inulin spherites is explicable as due to radial cracking. These cracks are exceedingly minute in starch and into them the air does not enter. They are larger in inulin spherites and are penetrated by air. The double refraction of both bodies is due to the strains under which the masses exist; strains which are not completely relieved in starch until the expansion due to true imbibition has passed over into the semi-solution of the gelatinous state. Both inulin and starch grains are thus considered to be

masses of colloid, homogeneous, except for the radial cracks. The material is arranged in layers or zones arising from internal differentiation.—C. R. B.

AMONG ANNUAL REPORTS from experiment stations, not heretofore noticed in these pages, are three from the New York station. Those for 1895 and and 1896, much delayed in appearing, have about one third the space devoted to the reports of the horticulturist, S. A. Beach, and mycologist, F. C. Stewart, and their assistants. The more strictly botanical portion in the 1895 report covers about 70 pages, dealing with fungous diseases and their remedies, with five excellent plates, and in the 1896 report there are 100 pages and ten fine plates. A part of this matter had been published elswhere. In the 1897 report no botanical matter appears that had not already been issued in bulletin form.

The report of the Rhode Island station for 1897 contains an article on use of sulfur and sulfate of Ammonia for prevention of potato scab (pp. 254–268) by H. J. Wheeler and G. E. Adams, showing that both substances have some value; and also an article on the asparagus rust (pp. 317–321) by L. F. Kinney, giving an account of a serious outbreak at Concord, Mass., the spread of the disease in Rhode Island, and attempts to control it.

The report of the Maine station for 1897 contains a valuable résumé of important writings on the acquisition of atmospheric nitrogen (pp. 114–140) by W. M. Munson, in which he cites both foreign and American literature, and appends a bibliography of 120 numbers. F. L. Harvey writes upon plants of the season (pp. 179–191), especially the weeds about which inquiries have been made, the king-devil (*Hieracium præaltum* Vill.) receiving most attention, including its history, distribution in America, habits and methods of prevention. The blighting effect of wind on maple leaves in spring is described, and some diseases are mentioned. Three species of stinkhorn fungi have been found in the state, *Phallus dæmonum* Rumple, *P. impudicus* L. and *Mutinus brevis* B. & C., which are described with the aid of a half-tone plate from a photograph of the first two.

In the report of the Delaware station for 1896–7 F. D. Chester gives an account of experiments for prevention of peach rot and apple scab by spraying, and of potato scab by use of sulfur (pp. 20–38), and also proposes a systematic arrangement of the species of the genus Bacterium (pp. 53–145), giving diagnostic characters and providing a bibliographic index.

The Hatch station of Massachusetts for 1897 devotes 24 pages (pp. 47–70) and two good plates to the report of the botanists, G. E. Stone and R. E. Smith. The subjects covered are the value of spraying, potato maladies of the year, "drop" of lettuce (*Botrytis*), asparagus rust (*Puccinia Asparagi*), fire blight of pears, quince rust (*Gymnosporangium clavipes*), brown rot of stone fruits (*Monilia fructigena*), chrysanthemum rust (*Puccinia Tanaceti*), a bacterical disease of the geranium, and four leaf blights of native trees.

The last report issued by the California station, being for 1895–1897, includes

an account of the natural vegetation of alkali lands (pp. 63–75) by J. Burtt Davy, illustrated with eight fine plates from photographs. The plates show *Frankenia grandifolia campestris* Gr., *Distichlis spicata* (L.) Greene, *Atriplex polycarpa* (Torr.) Wats., *Bigelovia veneta* (H. B. K.) Gr., *Suæda* Torreyana Wats., *Sporobolus airoides* Torr., *Allenrolfea occidentalis* (Wats.) Kuntze, and *Modiola decumbens* Don.

The report of the Connecticut station for 1897 is issued in parts, and part three (pp. 159–222) is entirely devoted to botany. The articles are by W. C. Sturgis, and present, with much fullness, a study of the mildew of lima beans (*Phytophthora Phaseoli* Thax.), stem rot of carnations, which was found to be due to a Fusarium, prevention of fungous diseases of celery and apple, and an extended classified index to the literature of fungous diseases, found chiefly in the publications of the U. S. Department of Agriculture and the state experiment stations.

The Arizona report for 1897–8 is very brief, containing only 40 pages. The botany (pp. 160–169) by J. W. Toumey treats especially of root-rot of Alfalfa, and sunburn of fruit trees, the latter being due to the action of a hot sun while the plants are in a wilting condition.

In the Wisconsin report for 1897–8 there are two important botanical studies by E. S. Goff. The first is an investigation of the resumption of root growth in spring (pp. 220–228), showing that the rootlets of trees and shrubs do not die away during winter, as usually taught, but that growth is resumed in spring where it ceased in the previous autumn. The second is a study of the morphology and habits of the strawberry plant (pp. 229–238). Both are well illustrated by cuts.

In the Vermont report for 1897–8 both the botanist and horticulturist write upon subjects that are largely botanical. The botanists, L. R. Jones and W. A. Orton, present a variety of topics (pp. 189–236). Valuable results are recorded in spraying potatoes and apples for fungous diseases, and in treating potatoes, especially with formalin, for scab. In 1897 the asparagus rust and club-root of cabbage were first reported in the state. A list of the parasitic fungi of the state with their hosts includes 17 species of Phycomycetes, 27 of Erysipheæ, 15 of Ustilagineæ, and 80 of Uredineæ. There are interesting observations on weeds, and on impurities in clover seed. A study of the flow of maple sap shows close correspondence between changes of temperature and rates of flow, and by use of lithium it was found that the sap flowed equally well up or down the trunk, but very slowly in a radial direction. F. A. Waugh, the horticulturist, reports (pp. 237–306) with great fullness upon the study of plums, their pollination, self-sterility, hardiness, and blossoming seasons, to which is added a monograph of the Wayland group of plums, all amply illustrated. There are also notes on lilies, on physiological constants, on use of enzyms in germination, and on winter-killing of buds, all treated with originality, and full of valuble facts.—J. C. A.

IN *Journal de Botanique* **13**: 127, M. Ph. Van Tieghem proposes to discriminate the non-sexual reproductive bodies now called spores into three categories. (1) The term *spores* he retains for those bodies which are formed by an adult plant and develop into a new "adult" individual. All the fungi and most of the algæ form spores; the gemmæ or brood-buds of bryophytes are spores; but no vascular plants produce spores. (2) The term *diodes* (from διόδος, passage = transition) is suggested for reproductive bodies, arising on the adult, which develop into a "rudimentary" body, the prothallium thus establishing a transition between the "adult" and "rudimentary" stages. Thallophytes and bryophytes have no diodes; they are peculiar to vascular plants. The diodes may be all alike (isodiody), or differentiated into microdiodes and macrodiodes (heterodiody). (3) All the bryophytes, the Rhodophyceæ and Mucoraceæ produce and set free viable cells which are not spores, because they do not arise from the adult stage, and not diodes, because they produce directly an adult individual. To them is given the name *tomies*, from τομή, to cut, because by them the total development from the egg is "cut" into two unequal parts, the smaller preceding the tomies, the larger following their growth. The rudimentary structure in which they are formed is the tomiogone.

The application of these new terms is obvious enough, but to the writer they seem worse than useless because they obscure homologies — which is also obvious enough. — C. R. B.

NEWS.

PROFESSOR DR. W. ZOPF has been called from Halle to Münster as successor to Dr. O. Brefeld.

DR. OTTO STAPF has been promoted to chief assistant in the Kew herbarium, succeeding Mr. W. B. Hemsley.

A COMMITTEE has been formed to collect funds for a marble bust of the late Dr. Guiseppe Gibelli, professor of botany in the University of Turin.

PROFESSOR DR. G. KARSTEN, of Kiel, has been called to the assistant professorship of botany at Bonn, as successor to Professor Dr. A. F. W. Schimper.

THE BOTANICAL INSTITUTE of Rome, under the direction of Professor R. Pirotta, held during March and April a series of public conferences on the nutrition of plants.

DR. J. M. JANSE has been appointed to the directorship of the botanical garden at Leyden, a post held by the late Professor W. F. R. Suringar for more than thirty-five years.

ASSOCIATE PROFESSOR W. C. STEVENS, of the University of Kansas, has recently been promoted to the professorship of botany, and Assistant Professor M. A. Barber to associate professor of bacteriology and cryptogamic botany.

DR. A. P. ANDERSON has been appointed assistant professor of botany, in charge of plant physiology, in the University of Minnesota, *vice* Dr. D. T. MacDougal, who recently resigned to accept the directorship of the laboratories of the New York Botanical Garden.

DR. L. BUSCALIONI, assistant in the botanical institute at Rome, left on March 15 for a long expedition in Brazil. There, accompanied by a collector for the botanical museum, he intends to explore the little known regions of the upper affluents of the Amazon, and to cross the Andes.

MR. CHAS. A. KEFFER, for the past five years assistant chief of Division of Forestry, U. S. Department of Agriculture, has resigned to accept a position as head of the department of horticulture and agriculture in the New Mexico Agricultural College at Mesilla Park, New Mexico.—*The Forester*, March.

A BUST of Dr. Increase A. Lapham, a pioneer naturalist of Wisconsin (1836–1875), was recently unveiled in the magnificent new public library and museum of Milwaukee. Lapham made extensive collections of plants in Wisconsin and northern Michigan, which are to be found in the great herbaria. His own herbarium is at the University of Wisconsin.

L'ABBÉ Count Francesco Castracane degli Antelminelli, the venerable student of diatoms, died at Rome on the 27th of March. He was born at Fano, July 19, 1817, and was therefore, in his eighty-second year. At the time of his death he was president of the Academie Pontifice des Nuovi Lincei.— DE TONI.

DR. A. W. CHAPMAN died suddenly at his home in Apalachicola, Florida, April 6, in his ninetieth year. This venerable American botanist, so long identified with the flora of the southern states, continued his botanical work until the last. A biographical sketch, prepared by Dr. Charles Mohr, will be published in the next number of the BOTANICAL GAZETTE.

THE SOCIÉTÉ de physique et d'histoire naturelle, of Geneva, announces a competition for the prize of 500 francs, founded by A. P. DeCandolle, for the best unpublished monograph of a genus or family of plants. The manuscripts, to be written in Latin, French, German, Italian, or English, must be sent to the president of the society before January 15, 1900. If agreeable to the author of the work receiving the award, the society will publish it in its quarto *Mémoires*.

MR. J. DÖRFLER, the compiler of the best and most complete *Botanists' Directory*, expects to issue a new edition about the beginning of 1900. Address slips will soon be distributed. It is to be hoped that all botanists will furnish the information desired. The great value of a complete directory is patent, but its accuracy and completeness depend largely on the cooperation of all to whom address blanks come. Mr. Dorfler's address is Barichgasse 36, Wien, III, Austria.

THE GROUNDS of the new Cruickshank botanical garden, in connection with the University of Aberdeen, are shortly to be laid out. The total area is between five and six acres, of which about half an acre is placed at the disposal of the agricultural department of the University. Provision is to be made at present only for a museum, and for the study of systematic botany; later the trustees contemplate erecting suitable quarters for physiological work. Dr. J. W. H. Traill is the director.

THE TWELFTH annual session of the Marine Biological Laboratory opens at Woods Hole, Mass., on June 1, and closes October 1. Two courses of instruction in botany are offered, one in cryptogamic botany and one in cytol-

ogy, to begin July 5 and close August 16. The botanical staff consists of Dr. Bradley Moore Davis, instructor in botany, The University of Chicago, and George T. Moore, Jr., assistant in botany, Harvard University. Fourteen botanists are also announced for lectures on special subjects. Further information may be obtained from Dr. Davis.

FROM THE annual announcement of the Woods Hole Marine Biological Laboratory we clip the following:

"After the close of the current volume in April, the *Zoological Bulletin* will be continued under the title, the *Biological Bulletin*, and be published under the auspices of the Marine Biological Laboratory. The scope of the *Bulletin* will be enlarged so as to include general biology, physiology, and botany. It will further include occasional reviews and reports of work and lectures at the Laboratory. The *Bulletin* will be open, as heretofore, to scientific contributions from any source."

THE DEATH of Charles Naudin occurred suddenly on March 19th. Naudin was director of the experimental garden at the Villa Thuret, Antibes, an adjunct of the Jardin des Plantes, Paris. He was born at Autun in 1815, and was therefore in his eighty-fourth year. His experimental researches on Cucurbitaceæ, enabling him to untangle and classify the confusing varieties of gourds, cucumbers, and melons; his *Traité général d' horticulture*, one of the most useful of horticultural works; and his numerous experiments and writings on acclimatization and hybridization make secure his fame as one of the greatest garden botanists of the century.

DR. GUSTAV RADDE, director of the museum in Tiflis, has recently published the third memoir in the Engler and Drude series *Die Vegetation der Erde*, entitled *Grundzüge der Pflanzenverbreitung in den Kaukasusländern*, which will be shortly reviewed in our pages. In recognition of Radde's services as founder and director of the Tiflis museum, his long and active scientific career of forty-five years, and especially his investigations on the fauna and flora of eastern Siberia and principally in the Caucasus, which culminate in the recently published memoir, the Imperial Geographical Society of St. Petersburg has conferred upon him its highest honor, the Nicolajewicz gold medal.

MISS CLARA E. CUMMINGS has just issued another fascicle of *Lichenes Boreali-Americani*. This fascicle contains numbers 221–250, and is the most valuable yet issued. Of the thirty species, twenty-three are mountain forms, from the Franconia mountains in New Hampshire, mountains of Colorado, and one from the Sierra Nevada. Other specimens are from Montana, Nebraska, Pennsylvania, Louisiana, and the District of Columbia. Twelve of the thirty specimens are rock forms, mostly of the genera Lecanora and

Lecidea. These have all been compared with the Tuckerman herbarium, and as the rock lichens are peculiarly difficult to determine, they are the most valuable forms to be included in an authentic set. The author still needs the assistance of collectors, and the sets will be issued as fast as material can be obtained.

DR. A. F. WOODS, of the United States Department of Agriculture, has an account in *Science* of April 7, of some interesting results he has recently obtained relative to a so-called disease of the vine. It appears that some years ago two French investigators, Viola and Sauvageau, discovered what they supposed to be a new parasitic organism causing much damage to the vine. Dr. Woods has conducted a similar investigation, and reaches the conclusion that their results are due entirely to the reagents employed in the study. That is, by using certain staining fluids, the contents of vegetable cells may be made to assume at will the form described by the French authors as their new organism. Dr. Woods was able to produce precisely similar results in lily, tobacco, tomato, rose, hyacinth, and even in spirogyra cells. The complete report will soon be published by the Department of Agriculture.—*Plant World*, May.

AT THE MEETING of the Academy of Science of St. Louis, on April 3, Mr. Trelease exhibited a plaster cast of a gigantic monstrosity of *Cereus marginatus*, known as the Rosa de Organo, presented to the Missouri Botanical Garden by Professor Frederick Starr, and reported that this formation was locally abundant at points south from Aguas Calientes. The speaker exhibited a large number of comparable cactus monstrosities from the plant-houses of the Missouri Botanical Garden and the collection of the president of the Cactus Association of St. Louis, and a similar deformity of one of the cactus-like Euphorbias of the African region, commenting on this teratological type. It was shown that for the purpose of gardeners, for whom these unusual forms appear to possess a considerable interest, they are commonly divided into two types, in one of which, commonly designated by the varietal name *cristata* or *cristatus*, the monstrosity takes the form of a fan or a contorted ridge, while in the other, commonly designated by the varietal name *monstrosa* or *monstrosus*, it consists of irregular bunching of the branches, and an interruption of the customary longitudinal ridges of such a genus as Cereus.—W. T.

FROM *Nature* for March 16, 1899, we take the following announcements of forthcoming botanical books:

Mr. Edward Arnold announces "A manual of botany," by David Houston; and "Wood: its natural history and industrial applications," by Professor G. S. Boulger. — The list of Messrs. C. J. Clay & Sons (Cambridge University Press) includes "Fossil plants," a manual for students of botany and geology,

by A. C. Seward, F. R. S., Vol. II; and "The soluble ferments and fermentation," by Professor J. Reynolds Green, F. R. S. — Messrs. Duckworth & Co. give notice of "A glossary of botanic terms," by B. Daydon Jackson; "A text-book of agricultural botany, theoretical and practical," by Professor John Percival; and "A text-book of plant diseases caused by cryptogamic parasites," by George Massee. — Mr. W. Engelmann (Leipzig) announces "Grundzüge der Pflanzenverbreitung in den Kaukasuslanden," by Dr. Gustav Radde. — Mr. Henry Frowde announces Goebel's "Organographie der Pflanzen," translated by Professor L. Bayley Balfour, F. R. S.; and Pfeffer's "Pflanzenphysiologie," translated by Dr. A. G. Ewart. — Messrs. Longmans & Co. promise "The flora of Cheshire," by the late Lord de Tabley. — The list of Messrs. Swan Sonnenschein & Co., Ltd., contains a new edition of "Handbook of practical botany," by Professor E. Strasburger, translated and edited by Professor W. Hillhouse.